POWER

Vol. 43 NEW YORK, MARCH 7, 1916 No. 10

The Hall of Records Test Controversy Begins

See the editorial, page 329

FROM R. P. BOLTON'S REPORT ON THE HALL OF RECORDS TEST

Conclusion:

Under the existing conditions the plant can be abandoned and from $7,000 to $10,000 saved annually.

In a new undertaking, the saving would be from $20,000 to $25,000 in favor of the utilization of external supplies of light, heat and power.

R. P. BOLTON.

FROM THE NEW YORK PRESS, FEB. 25, 1916

...steamship Maracas.

ENGINEER IS ACCUSED OF A BREACH OF FAITH

Edison Employe Charged with Issuing False Statement of City Test.

Charging breach of faith on the part of Reginald P. Bolton, engineer for the New York Edison Company, the Bureau of Municipal Research last night submitted to Mayor Mitchel a report on the test of the steam and electric light plant in the basement of the Hall of Records.

The row grew out of a test made by six engineers, two representing the Edison company, two representing the city and two representing the Bureau of Municipal Research, to determine whether the Edison company could supply the steam and electric power for the City Hall, County Court House, City Court and Hall of Records cheaper than it now costs the city to run its own plant. Professors Rolla C. Carpenter and Charles E. Lucke, represented the Research Bureau; R. P. Bolton and Professor R. F. Tweedy the Edison company, and E. P. Goodrich and Professor George F. Sever the city.

On February 14 last, after the Edison company had protested many times at the delay in making public the report, Bolton gave out a statement, to the effect that the city would save about $4,000 a year if it would discontinue its own plant in the Hall of Records building and permit the Edison company to supply the electric current and the steam. In other words, Bolton stated that it cost the city more than $39,000 a year to run the plant, whereas the Edison company could supply the service for $35,000 yearly.

In its report to the Mayor, the Bureau of Municipal Research says:

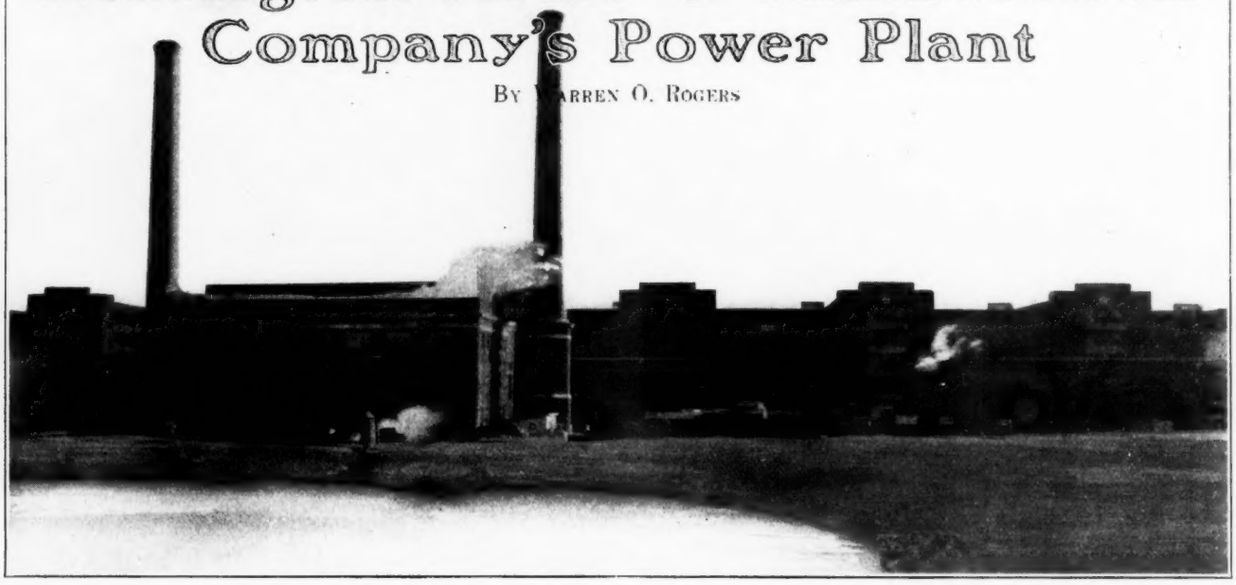
"The fact is that the engineers forming the board have not agreed, and up to the present time have not issued any official report. "The opinion of the bureau engineers, based upon the facts produced during the test, is that the city can operate the Hall of Records plant more cheaply without Edison service than with it, even if the plant and service remain unchanged, unless a much cheaper rate for electric current becomes available."

The report then states that the city would lose about $9,400 a year if the Edison company were permitted to supply the service.

END OF ... AY IS NE...

Remington Arms & Ammunition Company's Power Plant

By Warren O. Rogers



SYNOPSIS—A steam-turbine power plant erected and put in operation in 90 days. Bleeder, mixed-pressure and high-pressure turbines are installed. Reduction gears are used on some of the condensers between the turbine drive and pumps. The three exciter units have both turbine and motor drive. By this arrangement the units can be operated by either motor or turbine, and as the turbine is always under steam, if a motor fails the emergency valve on the turbine permits it to immediately pick up the load, thus continuing the unit in operation without interruption of service.

On Mar. 3, 1915, the site of the now practically completed power plant of the Remington Arms and Ammunition Co., Bridgeport, Conn., was void of anything indicating a manufacturing plant. Seventy days later No. 1 unit, of 750-kw. capacity, was carrying a commercial load, and Nos. 2 and 3 units were carrying a load 20 days after starting the first one. Thus in 90 days a power plant of 4,750-kw. capacity had been designed, erected and placed in operation. The work was done by the Stone & Webster Engineering Corporation.

Before the original plant was completed in detail, it was decided to increase the capacity 8,000-kw., making a total of 12,750-kw., with space for another 4,000-kw. unit. The boilers are eight in number, each having 6,000 sq.ft. of heating surface and 948 sq.ft. of superheater surface. The total rating is 4,800 boiler horsepower.

This plant will supply electrical energy to the new arms factory, a part view of which is shown in the illustration at the head of this article. The main buildings are five stories high and contain 1,538,000 sq.ft. of floor space, or over 35 acres. The structure is declared to be the largest of its kind in the world under one roof. The machinery in this and smaller buildings connected with the works, together with that of the cartridge factory, a separate establishment, will use the energy generated in the power plant.

The principal equipment includes five turbo-generators and the eight water-tube boilers. A general view of the turbine room is shown in Fig. 1. The 750-kw. turbine is of the bleeder type, as is also one of the 2,000-kw. units. The other 2,000-kw. turbine is of both mixed-pressure and bleeder design. These turbines will deliver steam at 15 lb. gage to low-pressure mains for processes in the factory; the exhaust of all hammers, etc., in the shops will also be led to the low-pressure main. The excess exhaust steam from the plant auxiliary turbines, when there is any, will be fed into No. 3 unit. Steam from the low-pressure main heats the water for heating the factory buildings.

The two 4,000-kw. units, 80-per cent. power factor, are of the horizontal type. All of the generating units run at 3,600 r.p.m., use steam at 175 lb. pressure superheated 125 deg. F. and generate current at 2,300 volts three-phase 60-cycles. Each turbine has an automatic stop valve. Also in the turbine room are the switchboard instrument and transformers, which are at one end of the room, and the gages and recording instruments at each turbine. The general arrangement of the units is shown in the plan view, Fig. 6.

Each turbine is connected to a separate jet condenser, in the basement. The pumps on the condenser serving the 750-kw. unit are driven by a turbine at 4,500 r.p.m., through a reducing gear that brings the speed of the pumps down to 1,500 r.p.m. The pumps for No. 3 unit are driven at 1,200 r.p.m. through a reducing gear by a turbine running at 3,600 r.p.m. A similar arrangement is used with the two 4,000-kw. units, the reduction in speed, however, being from 3,000 to 1,000 r.p.m.

Water for the condensers is obtained from a natural pond supply, and any deficiency during the summer months is made up from the city mains. Two 36-in. intake pipes run from the pond to a point opposite a center line through the condensers, where a tee connection is placed, one end of which is plugged for future extension should it be necessary. From these tees the line runs to and below the five condensers, but is reduced to 24 in. at No. 2 unit and to 15 in. at No. 1 unit.

The discharge line is 36 in. diameter and discharges either into the pond in winter or to spray cooling nozzles during the warmer months. The discharge line from No. 1 condenser, which operates with the 750-kw. turbine, is 15 in. diameter and enlarges to 36 in. where the 20-in. branch line from No. 2 condenser connects with the main discharge line. The discharge branches from the other condensers are of the same diameter. There are two 36-in. discharge lines from the main discharge header to the pond. A plan of this piping is shown in Fig. 2.

A view of the spray nozzles and cooling pond is given in Fig. 5. Six lines branch from the reduced sections of the main 36-in. discharge pipe, each supplying water to 14 groups of five nozzles each, or 420 nozzles in all, which have a capacity of 15,750 gal. per min.

The plan of the basement, Fig. 2, shows the general layout of the auxiliary units. Recently there has been adopted a combination of turbine and motor drive for excitation service. If, when the motor is carrying the load, its current supply should fail, at a given drop of speed the load will be automatically taken by the turbine keeping the exciter in service. There are three 125-volt exciters, each driven by a 65-kw. turbine or by a 100-hp. induction motor, at 1,165 r.p.m. The turbine and motor are coupled at opposite ends of the direct-current generator shaft. Fig. 7 illustrates the combination units.

The various pumps are in bays on the side of the basement next to the boiler-room basement. These bays are formed by the three 180-in. diameter forced-draft fans, each of which is driven by a 7.5&13x6.5-in. vertical cross-compound engine running at a maximum speed of 260 r.p.m. Air is taken from the boiler-room basement and is also drawn from Nos. 1, 2 and 3 turbines through metal ducts, so that the air heated in passing through the generator casing is delivered to the stokers instead of discharging into the turbine room. Nos. 4 and 5 units discharge the heated air to the outside of the turbine building.

In the first bay, shown at the right in Fig. 2, are two turbines driving two centrifugal pumps, each with a capacity of 2,500 gal. per min., for heating service. The temperature of this water is thermostatically controlled, being circulated through the factory heating coils and heated by exhaust steam in two 2,500-gal. service heaters, which are above and at the rear end of the boilers. The second bay contains two 20-hp. induction motors that drive two 300-gal. capacity 4-in. volute pumps at 1,800 r.p.m. They supply hot water to the factory lavatories and to the kitchen for various purposes.

Two 100-hp. turbines in the third bay drive two 6-in. two-stage turbine fire pumps, each having a capacity of 1,000 gal. per min. against 100 lb. pressure and each capable of supplying four 1⅛-in. fire streams when running at 1,800 r.p.m.

At the left of Fig. 2 in the last bay are six pumps. Three are 4-in. volute and supply cold water to the factory. Each is driven by a 35-hp. motor at 1,800 r.p.m. These pumps, which have a capacity of 500 gal. per min., can also supply the feed-water heater. The other three three-stage boiler-feed pumps have a capacity of 300 gal. per min. against 250 lb. at 2,800 r.p.m. and are driven by three 80-hp. turbines. Fig. 3 shows one of three sets.

At the other end of the basement are two 1,500-cu.ft. per min., steam-driven cross-compound air compressors, Fig. 8. The steam cylinders are 14&25x20 in., the air cylinders 13&23x20 in. The air is compressed to 100 lb. pressure for use in the factory.

At the side of the basement opposite the fire-pumps is a small refrigerating plant for cooling drinking water

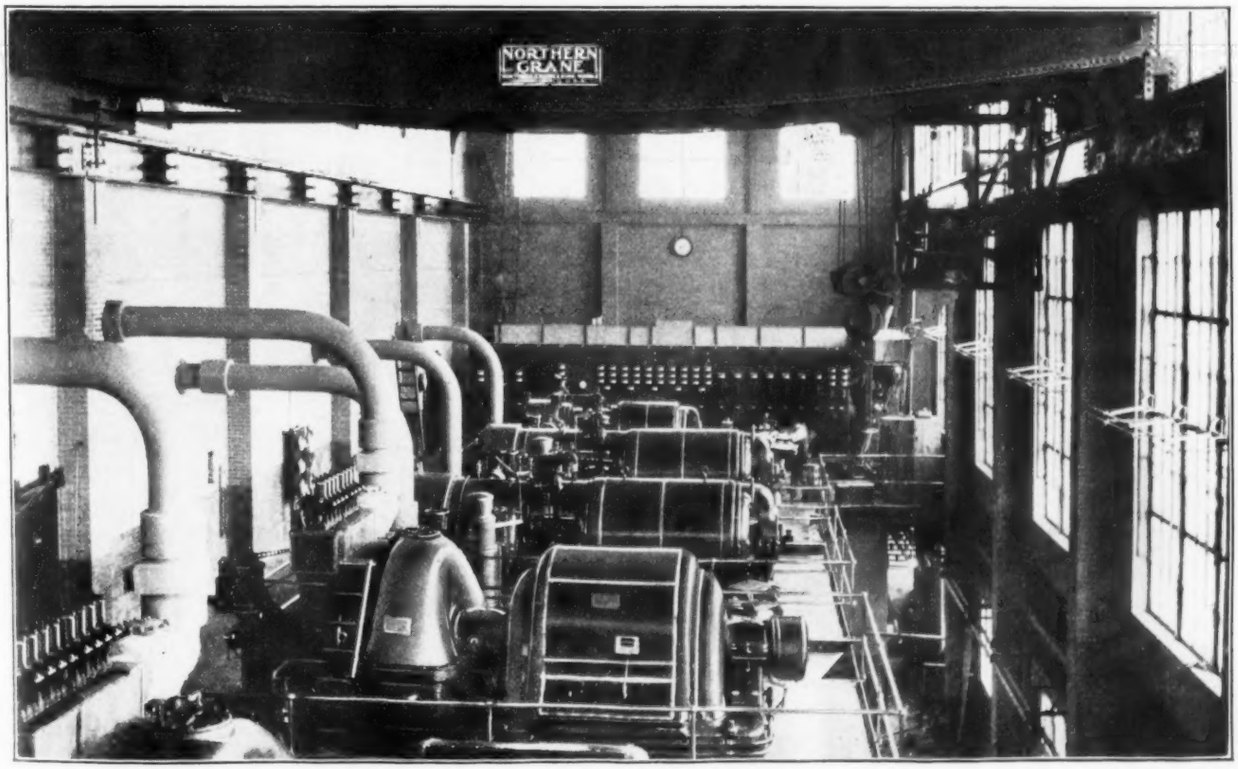


FIG. 1. GENERAL VIEW OF THE TURBINES OF THE REMINGTON ARMS AND AMMUNITION CO.'S POWER PLANT

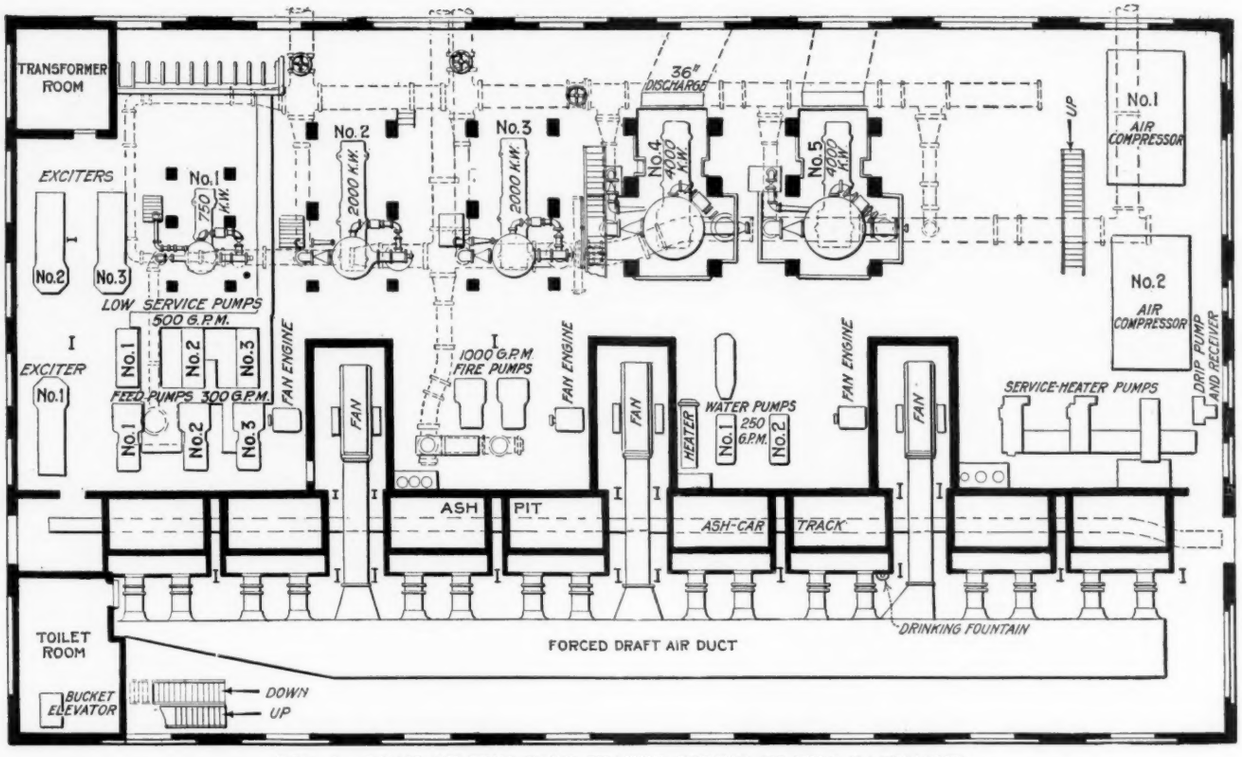


FIG. 2. PLAN OF THE COLD WATER PIPING IN THE BASEMENT

containing an ammonia compressor belt driven by a 35-hp. motor and a 1½-in. turbine pump driven by a 7½-hp. motor, for circulating the cooled water through the works.

In the boiler room the eight units are set in pairs, and the furnaces have seven-retort underfeed stokers. These are driven by either of two vertical stoker engines, one at each end of the boiler room, Fig. 6. They are chain-belted to a shaft that extends the length of the boiler settings in the basement. This shaft has a clutch at each end so that either engine can be connected, or disengaging a clutch at the center of the shafting each engine can operate four stokers independently.

A view of the firing aisle is shown in Fig. 4. The boilers are equipped with draft gages and steam-flow meters, and at one end of the boiler room is a large illuminated three-spring master steam gage. Recording gages give a record of the temperatures of the flue gases, which rarely exceed 400 deg. F. Each boiler has three pop safety valves which discharge into the boiler room and its setting is connected with a soot-blowing system. The feed water goes through either one of the duplicate 3-in. lines, the water level being governed at each boiler by a feed-water regulator. The feed water is metered.

Air from the three fans is discharged to a main forced-draft air duct through three connections. The main air duct is 7 ft. 3 in. wide and 4 ft. high at one end, giving an area of 29 sq.ft. These are the dimensions until No. 2 boiler is reached, when the height reduces at an angle to 2 ft. at the end. From the main air duct two 27-in. round branch pipes, each of 3.97 sq.ft. cross-sectional

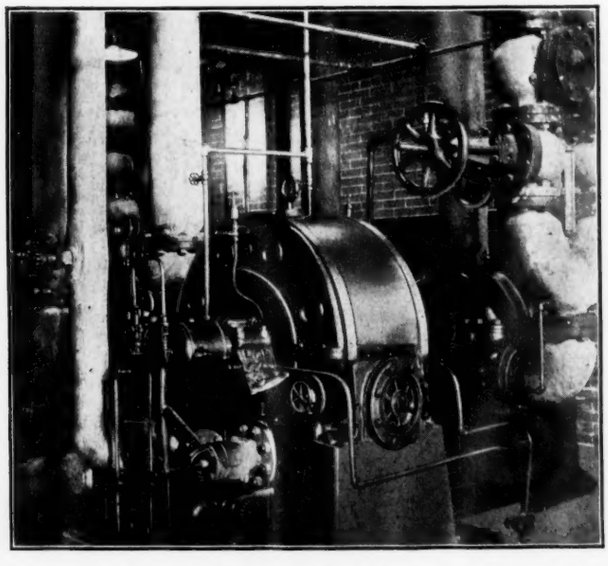


FIG. 3. TURBINE-DRIVEN BOILER-FEED PUMP

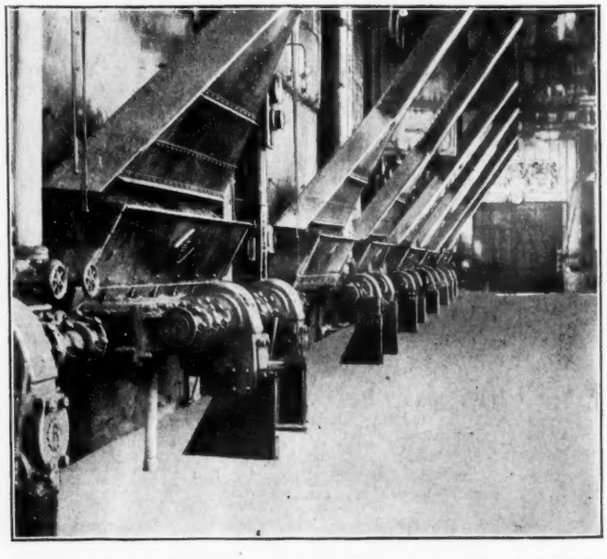


FIG. 4. FIRING AISLE AND SEVEN-RETORT STOKERS

FIG. 5. PARTIAL VIEW OF THE COOLING POND AND SPRAY NOZZLES

area, connect with the air chamber under the stoker grates. Provision is made for cutting off the air supply to the stoker of any boiler out of service.

The flue gases go from the last pass of each boiler to vertical breechings that extend from the rear of the boilers, at the top, to a metal smoke flue on the roof which connects with the two radial-brick chimneys, each 200 ft. high and 12 ft. inside diameter at the top. The flue is insulated and covered. The general arrangement of the various main units in the plant is shown in the cross-section, Fig. 9.

Coal is delivered in railroad cars to a track hopper, from which it goes through crushing rolls to a vertical incased bucket conveyor 83 ft. 6 in. center to center, capable of elevating 35 tons per hour. The lift is 85 ft., and the buckets travel at 100 ft. per min. At the top the coal is discharged upon an 18-in. belt conveyor 116 ft. long, center to center, with a capacity of 35 tons per hour at 150 ft. per min. The traveling tripper permits of evenly distributing the coal in the concrete-lined bunker 141 ft. long, that is supported above the firing aisle and holds 4¼ tons per lineal foot, or a total of 600 tons.

As the coal is elevated from the crushing rolls to the belt conveyor, a sample is automatically bypassed to a machine that grinds it to fine particles. A second grinder reduces the sample selected for analysis. Samples are taken from each new shipment as received.

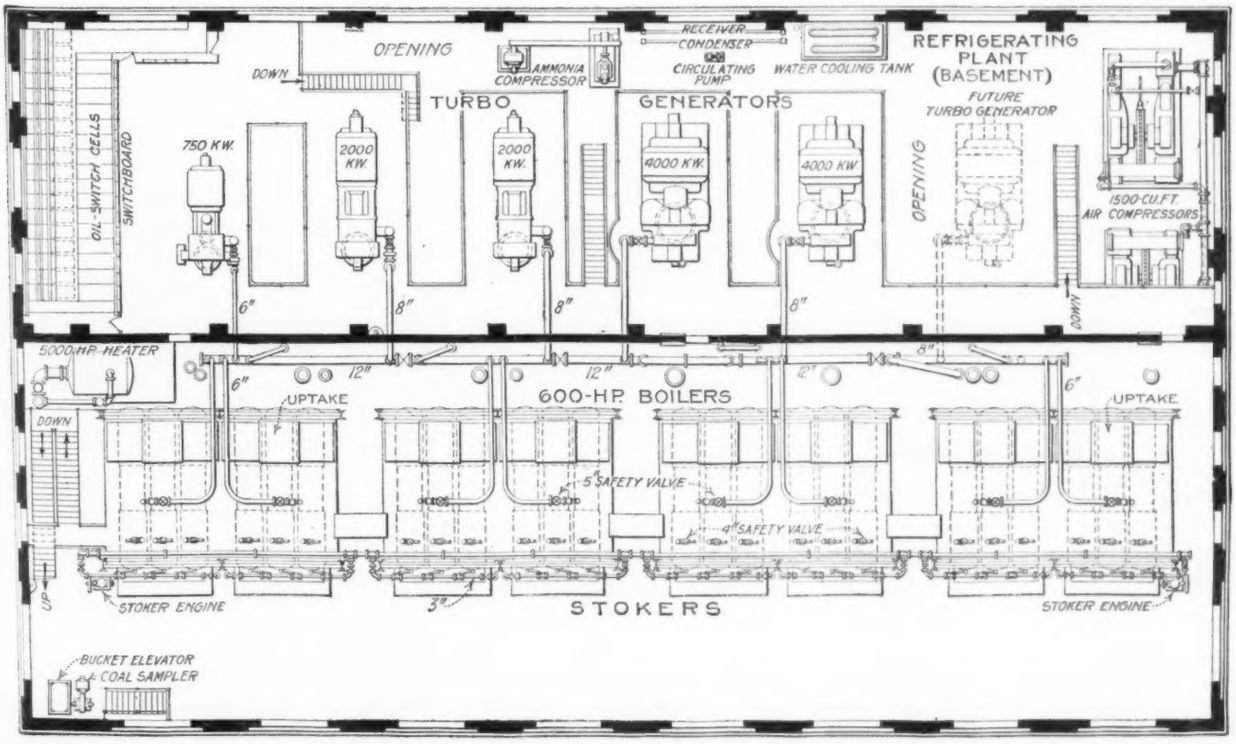


FIG. 6. GENERAL ARRANGEMENT OF TURBINE AND BOILER-ROOM APPARATUS

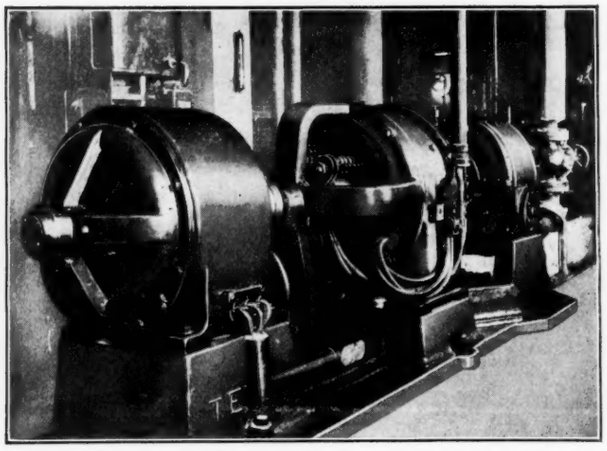


FIG. 7. TURBINE, MOTOR AND GENERATOR SET

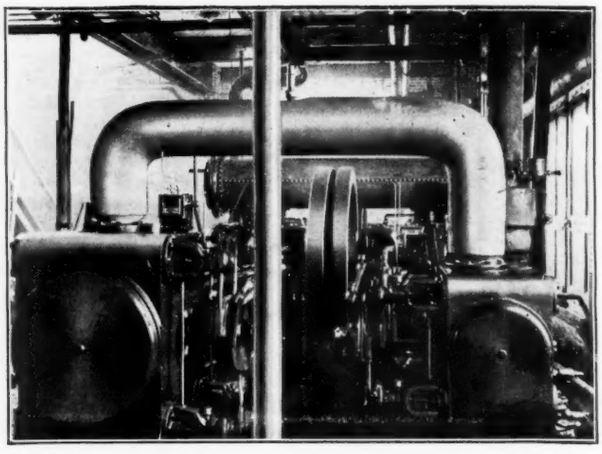


FIG. 8. STEAM-DRIVEN CROSS-COMPOUND COMPRESSORS

All coal in the bunker passes through the eight automatic scales, each discharging into a spout through which it is delivered to the stoker hoppers, thus automatically weighing the coal as it is used.

The disposal of ashes is simple. From the ashpit they are discharged into a car that runs on an industrial track below the pits. For the present they are used for grading.

The general layout of the main piping is shown in Figs. 6 and 9. Starting at the boilers, 6-in. branches with long-radius bends extend down to a 12-in. header at the rear of the boilers. This header is about 3 ft. above the floor and has an inverted U-bend at mid-section. It is so valved that in the event of accident to any section the others may be kept in use. This arrangement practically makes a unit-system installation of the turbines and boilers. Fig. 6 makes the layout clear. For instance, Nos. 1 and 2 units (750- and 2,000-kw. capacity respectively) may take steam from two boilers, No. 3 unit from another set of two boilers and so on, or other combinations may be made. The lead from the header to the smaller turbine is 6-in., those to the other four units are 8-in. Each is connected to the top of the header and long-radius bends do away with fittings and reduce the friction of the steam. Each turbine is connected through valve to a separate atmospheric-exhaust pipe. Each is 12 in. diameter except for the 750-kw. unit, which has a 10-in. exhaust line, and all extend above the roof.

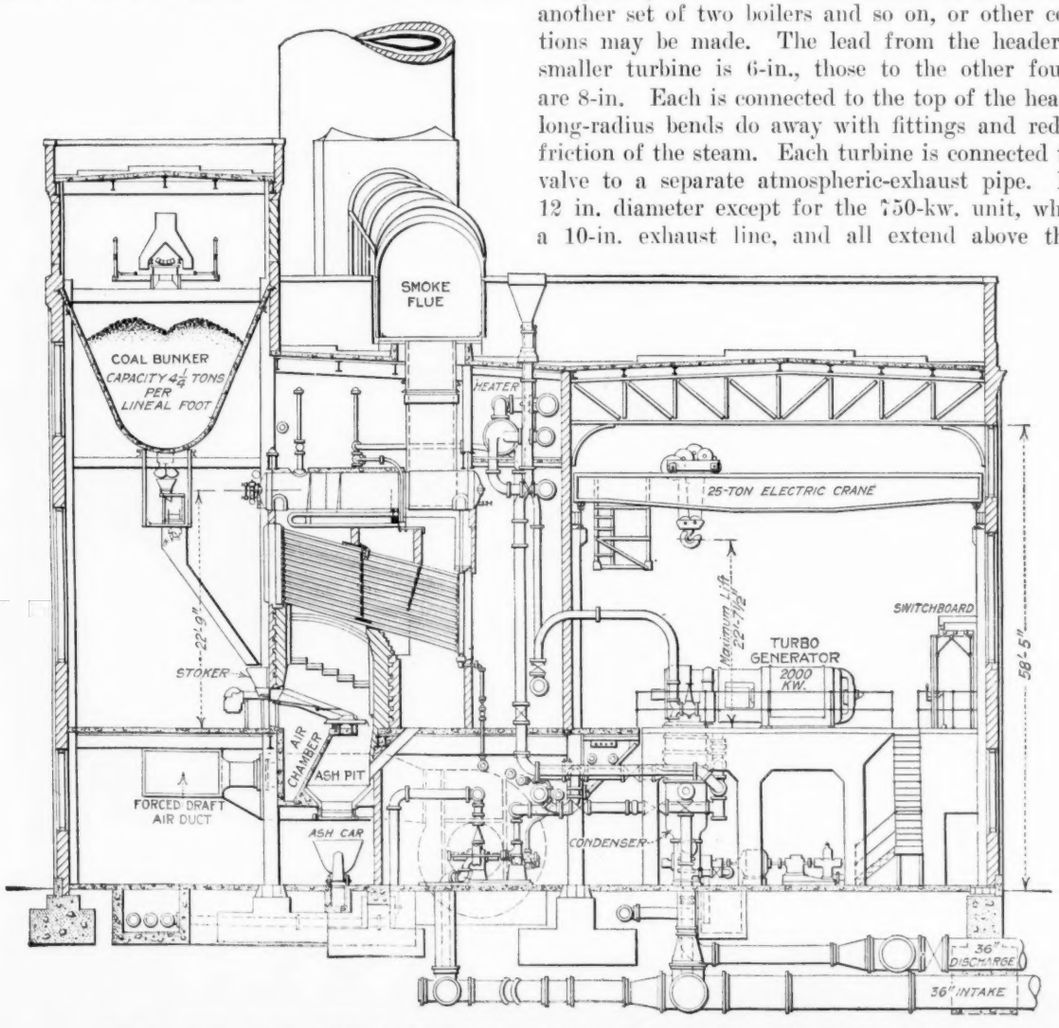


FIG. 9. END ELEVATION OF THE BOILER AND TURBINE ROOMS AND BASEMENT

Exhaust steam from the auxiliaries, when supplying the mixed-pressure turbine is taken from a 14-in. header along the ceiling of the basement. This connects with a 20-in. header back of the service heaters, from which connection is made to the feed-water heater that is above the boilers at one end of the boiler room. Another header connected to the bleeder turbines supplies steam to the two 2,500-gal. service heaters for heating the water used in heating the factory, and also supplying the lavatory. An atmospheric exhaust connected to this header relieves the service heaters of excess steam pressure. Practically all of the piping of the turbine and auxiliary units is in the basement close to the ceiling, which obviates congestion.

The purchase and installation of the original equipment were authorized Mar. 3, 1915. Early in June, after four boilers and the turbo-generators were in, it was decided to increase the capacity of the station from 4,750 to 12,750 kw. by adding two 4,000-kw. sets, as already stated, and also three more boilers, each having 6,000 sq.ft. of heating surface. The first of these additional units was ready for operation Oct. 1, and the other Oct. 22.

The manufacturers made such prompt deliveries that the first four boilers were being installed while the structural work of the buildings was being erected, and the turbines were being placed before the roof of the turbine room could be put on. Of credit to the designing engineers was the exceedingly short time taken in getting the plant into operation and in assembling but few errors were made in carrying out the work as designed.

The power plant is under the control of R. J. S. Pigott, power superintendent.

PRINCIPAL EQUIPMENT OF THE POWER PLANT OF THE REMINGTON ARMS AND AMMUNITION CO.

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
1	Turbo-generator	Bleeder	750-kw.	Main unit	175 lb. steam, 125 deg. superheat, 3,600 r.p.m., 2,300 volts, three-phase, 60-cycle	General Electric Co.
2	Turbo-generators	1 mixed pressure, 1 bleeder	2,000-kw.	Main unit		General Electric Co.
2	Turbo-generators	High-pressure and bleeder	4,000-kw.	Main unit		General Electric Co.
5	Valves	Automatic		Throttle to turbines	175-lb. pressure, automatic	Schutte & Koerting Co.
1	Condenser	Leblanc	No. 7	With 750-kw. turbine	Pumps turbine-driven, reduction gear 4,500 to 1,500 r.p.m.	Westinghouse Machine Co.
2	Condensers	Leblanc	No. 14	With 2,000-kw. turbines	Pumps 1 turbine-driven, reduction gear 3,600 to 1,200 r.p.m.; pumps 1 turbine and motor-driven, 1,170 r.p.m.	Westinghouse Machine Co.
2	Condensers	Leblanc	No. 19	With 4,000-kw. turbines	Pumps turbine-driven, reduction gear 3,000 to 1,000 r.p.m.	Westinghouse Machine Co.
3	Turbines	Terry	65-kw.	Driving exciter generators	1,200 r.p.m., 175 lb. steam	Terry Steam Turbine Co.
3	Generators	Direct-current	65-kw.	Exciter sets	1,200 r.p.m., 125 volts	General Electric Co.
3	Motors	Induction	100-hp.	Driving exciter generators	1,200 r.p.m., 2,300 volts, a.-c.	General Electric Co.
3	Fans	Steel-plate	180-in. dia.	Forced-draft	260 r.p.m. maximum	B. F. Sturtevant Co.
3	Engines	Compound vertical	7.5 x 13 x 6.5 in.	Driving draft fans	175 lb. steam, 260 r.p.m. maximum	B. F. Sturtevant Co.
3	Turbines	De Laval	140-hp.	Driving service pumps	175 lb. steam, 2,600 r.p.m.	De Laval Steam Turbine Co
3	Pumps	Centrifugal	2,500 gal. per min.	Hot-water service pumps	2,600 r.p.m., 80-lb. head	Jeanesville Iron Works Co.
2	Motors	Induction	20-hp.	Driving 4-in. volute pumps	440 volts, 1,800 r.p.m.	General Electric Co.
2	Pumps	Volute	300-gal., 4-in.	Lavatory and kitchen hot water	1,800 r.p.m., motor-driven	Jeanesville Iron Works Co.
2	Turbines	Terry	100-hp.	Driving fire pumps	175 lb. steam, 1,800 r.p.m.	Terry Steam Turbine Co.
2	Pumps	Turbine	1,000-gal. per min.	Fire pumps	1,800 r.p.m., 100 lb. head	Henry R. Worthington
3	Motors	Induction	35-hp.	Driving cold-water pumps	1,800 r.p.m., 3-phase, 60-cycle, 440 volts.	General Electric Co.
3	Pumps	Volute	500-gal. per min.	Cold-water	1,800 r.p.m. motor-driven	Jeanesville Iron Works Co.
3	Turbines	Terry	80-hp.	Driving boiler-feed pumps	175 lb. steam, 2,800 r.p.m.	Terry Steam Turbine Co.
3	Pumps	Three-stage	300-gal. per min.	Boiler-feed	2,800 r.p.m., motor-driven	Jeanesville Iron Works Co.
2	Heaters	Horizontal	2,500-gal.	Factory heating	Use exhaust steam	
1	Heater	Horizontal		Boiler-feed water	Use exhaust steam	Harrison Safety Boiler Works
1	Compressor	Vertical	15-ton	Cooling drinking water	Belt-driven by motor	Buffalo Refrigerating Mach. Co
1	Motor	Induction	35-hp.	Driving ammonia compressor	440 volts, 575 r.p.m., three-phase, 60-cycle	General Electric Co.
1	Motor	Induction	7.5-hp.	Driving cold drinking-water pump	440 volts, three-phase, 60-cycle	General Electric Co.
1	Pump	Centrifugal	1½-in.	Circulating cold drinking water	Motor driven	Henry R. Worthington
2	Compressors	Cross-compound.	Steam 14x25x20-in.; air 13x23x 20-in.	Air for factory	175 lb. steam, 100 lb. air	Ingersoll-Rand Co.
8	Boilers	Water-tube, B. & W.	6,000 sq.ft. ht. surface; 948 sq.ft. superheater	Steam generators	175 lb. steam, 125 deg. superheat	Babcock & Wilcox Co.
8	Stokers	Riley, underfeed.	7-retort	Boiler furnaces	Automatic engine-drive	Sanford Riley Stoker Co.
2	Engines	Vertical	6x7-in.	Driving stokers	Variable speed, 350 r.p.m. maximum	B. F. Sturtevant Co.
8	Gages	Draft		Furnace draft		American Steam Gauge and Valve Mfg. Co.
1	Gage	Three-spring		Master gage	175-lb. pressure	Ashton Valve Co.
8	Meters	Steam	Indicating	Indicates steam generation		Republic Flow Meter Co.
8	Tube blowers	Vulcan		Cleaning boiler tubes	Intermittent	Vulcan Soot Cleaner Co.
24	Valves	Pop safety		On boilers	Pop at 175 lb.	Consolidated Safety Valve Co.
8	Regulators	Copes		Regulating feed-water level	Automatic	Erie Pump and Equipment Co.
1	Meter	Simplex	6x3-in.	Metering feed water	Automatic	Simplex Valve and Meter Co.
2	Chimneys	Radial-brick	200 ft. high, 12 ft. inside dia.	Flue gases	Forced draft	Alphonse Custodis Chimney Construction Co.
1	Bunker	Coal	600-ton	Coal supply to stokers		Bergquist Suspended Bunker
8	Scales	Coal		Weighing stoker coal	Automatic	Richardson Scale Co.
1	Crusher	Rotary		Grinding sample coal	As wanted, with new cargo of coal	Sturtevant Mill Co.
	Covering	Magnesia, 85%	Various	Steam and hot water		Nightengale & Childs
	Covering	Cork	Various	Ice-water system		Nightengale & Childs
1	Crusher	Coal	35-ton per hr.	Bunker coal	Motor-driven	Robins Conveying Belt Co.
1	Elevator	Bucket	35-ton per hr.	Coal to belt conveyor		Robins Conveying Belt Co.
1	Conveyor	Belt	18-in.	From bucket conveyor to bunker		Robins Conveying Belt Co.
1	Crane	Locomotive		Coal and ash handling and stocking		Brown Hoisting Machinery Co.
20	Gages	Temp. pressure	10-in.	Steam, air and water	Recording	Industrial Instrument Co.
1	Meter	Venturi water	16x8-in.	Heating-system circulation	205 deg. F. hot water	American District Steam Co.
1	Meter	Venturi water	10x5-in.	Cold water to factory	70 deg. F. cold water	American District Steam Co.
1	Meter	Venturi water	6x3-in.	Hot water	150 deg. F. hot water	American District Steam Co.
1	Meter		8-in.	High-pressure steam to factory	100 lb. pressure, 150 deg. superheat	
3	Meters	Pitot	16, 4, 8-in.	Low-pressure, high-pressure steam and compressed air	Steam and air	Republic Flow Meter Co.

An Underfeed Stoker is able to smokelessly burn even high-volatile coals, because when the volatile is distilled, it must pass through the hottest part of the fuel bed before getting out into the furnace. Besides a sufficiently high temperature, the only other chief requirement for the proper burning of the volatile is time, just as it takes time for a cake of ice to melt at summer heat.

Files Can Be Cleaned of Grease after removing loose dirt with a stiff brush by boiling them for about 45 min. in a solution consisting of ¼ lb. of saleratus to a quart of water. The files are then thoroughly washed in clean water and dried and placed on end, completely submerged in a solution consisting of ¼ lb. of sulphuric acid to a quart of water. After remaining in the acid solution for about 12 hours the files should be thoroughly washed in clean water, quickly dried and given a light coating of kerosene or other thin oil to prevent rusting.

Parallel Operation of Direct-Current Generators--II

By Alan M. Bennett

SYNOPSIS—The requirements of successful parallel operation of three-wire generators and of rotary balancers is taken up and typical diagrams of connections shown. In a previous article the author discussed the parallel operation of shunt, series and compound generators.

Three-wire generators can be operated in parallel as satisfactorily as two-wire generators. They are always compound-wound, and that they may be self-regulating when the two sides of the system are unbalanced, the series field is in two sections, alternate poles being joined; one section is connected to the positive side of the generator and the other to the negative. Two equalizers are thus required, one for each section of the series field, and as these equalizers are connected to the armature terminals, the full potential of the generator exists between them and they must be treated the same as the mains from the generator as regards spacing, insulation, etc. Fig. 5 shows the connections for two three-wire generators in parallel. The action of the equalizer is the same as in the case of two-wire machines, serving as a path for current from a higher to a lower potential and tending to keep the voltage of the two machines the same and the load proportionately divided. The same requirement obtains as in the case of two-wire generators, namely, the compounding of the machines must be adjusted to practically the same degree and the drop in the series-field circuits of the several machines must be equal.

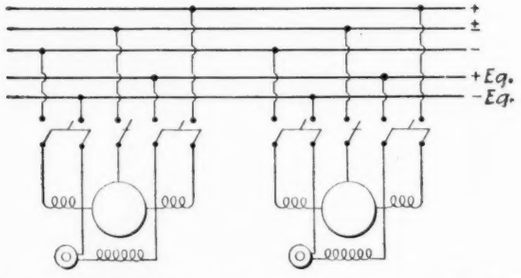


FIG. 5. THREE-WIRE GENERATORS IN PARALLEL

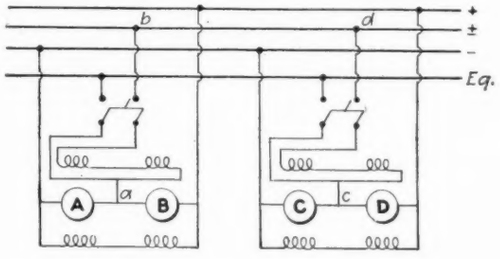


FIG. 6. COMPOUND BALANCERS IN PARALLEL

The usual switch equipment is a double-pole switch in the main and equalizer leads from each side of the generator and a single-pole switch in the neutral. As regards the circuit-breaker equipment, there is considerable difference of opinion as to the number required and their proper placing. In order to give absolute protection to the generator, however, the circuit-breaker must be placed in the line between the armature and the series field, for only in this position will the equalizing current, as well as that through the mains, pass through the breaker. This requires that the breaker be of the two-pole type, one pole in the line from each side of the machine; and the two poles must be interlocked so that both open together, otherwise one pole only might open, leaving the circuit through the neutral wire and the other side of the machine closed, with possible injury to the compensator.

As the full potential of the system exists between the equalizers, there is danger of short-circuit through the armature of the incoming machine unless its voltage is up to that of the system before being thrown into circuit. For this reason three-wire generators should be equalized before being paralleled, and with the circuit-breakers placed as stated, this can be done by closing the two-pole switches and leaving the circuit-breakers open, the series fields thus being connected to the circuit. This has the advantages that voltage disturbances on the system are reduced to a minimum, the danger of short-circuit is lessened and any reversal of polarity that may have occurred is corrected. After the generator has been brought up to voltage, it can be put in circuit by closing the circuit-breakers.

Another arrangement of circuit-breakers sometimes used consists in having a three-pole breaker with a pole connected in the main and equalizer leads from one side of the generator and the third pole in the neutral, the pole in the equalizer leg not having a tripping coil. If the three poles are interlocked, the circuit through the generator is completely opened when the breaker opens.

A third arrangement, which is quite common, consists of a four-pole circuit-breaker with a pole in each main and equalizer from the generator, all four poles being interlocked and only the poles in the mains having tripping coils. In the last two schemes of connections the breakers must be placed in the lines beyond the series fields, and in this position they are not influenced by the current that passes by way of the equalizer. Also, it is not possible to have the series coils in circuit before paralleling, as the circuit would be closed through the incoming machine and its armature would short-circuit the machines already in operation.

Three-wire generators may be operated in parallel with two-wire generators without difficulty, by arranging the series fields of the two-wire generator in two sections and using two equalizing connections. In this case the total unbalanced load will be carried by the three-wire generator provided its compensator is of sufficient capacity.

On three-wire systems operating with rotary balancers, it is desirable under certain conditions to have the unbalanced load divided among two or more such balancer sets,

and in these cases it is necessary that parallel operation of these sets be possible. Rotary balancers are generally compound wound, but several methods of connecting the series fields in circuit are in use, and the equalizing connections depend on the method used. Fig. 6 shows two balancer sets in parallel, having the series fields connected in the neutral circuit. The same current flows through both fields of a set, and for this reason one equalizer only is needed, connected as shown. A requisite to proper division of current between the two sets is that they have the same degree of compounding and that the voltage drop from *a* to *b* be the same as that from *c* to *d* when the sets are carrying their proportionate shares of unbalanced load. Any difference in these drops sufficient to cause an unequal division of load can be corrected by the addition of resistance to one or the other of the series-field circuits, as described for compound generators.

How an Equalizer Equalizes the Load

In order to understand the action of the equalizer it is necessary to know that the series fields of a balancer are connected so that they strengthen the shunt field of the machine running as a generator and weaken that of the machine running as a motor. Suppose the load between the positive and neutral busbars to be the greater, then the end of each set connected to the positive bus will run as a generator and the other as a motor. If for some reason the set *AB* should become more heavily loaded than the other, the point *a* will be at a higher potential than *c* and current will flow from *a* to *c* through the equalizer and thence to *d* through the series fields of the set *CD*. The action of this current will be to weaken the fields of the motor, thus raising the speed of the set, and this, combined with the strengthening action of the current on the generator fields, will cause an increase of voltage at the generator terminals, tending to restore the voltage balance of the sets and equalizing the load.

Instead of being connected in the neutral circuit as described, the series field of each machine is sometimes connected in its armature circuit. The fields in this case are independent of each other, there is more current in one than the other, depending on which machine is operating as a motor, and two equalizers will be necessary, taken off at the junction of the series field with the armature lead. This arrangement of series fields is not much used, however, as the regulation obtained is not so good as where the series field is connected in the neutral circuit.

When a single equalizing connection is employed, two double-pole switches are used, one in the two outside connections and the other in the neutral and equalizer from each set. The equalizer connection is thus closed at the same time as the neutral circuit.

In paralleling balancer sets it is not necessary to bring them up to a specified voltage before throwing them in circuit. They are brought up to speed with an ordinary starting box connected in series with the two machines, both of which run as motors across the outside mains. The switch in the neutral circuit must be open while the balancer is being started and closed to put the set in operation.

Cylinder Oil Containing Fatty Acid should be avoided, as it is apt to injure the metal. The acid absorbed by the piston and valve-rod packing sometimes attacks the rods, when the engine is out of service, to a serious extent.

Lubricants and Lubrication

By John D. Morgan

It has long been recognized that one of the best lubricating mediums is that obtained by the fractional distillation of crude petroleum. As a general average the amount of lubricating oil obtained from 52 gal. of crude oil is about 9.1 gal. of a specific gravity varying from 0.87 to 0.92, with a boiling point upward of 470 deg. F. The average total cost of lubricants for turbo-generators per 1,000 kw. will vary between 1.7 and 3c., and where reciprocating engines are used this cost will vary between 10 and 14c. per 1,000 kw.

Any efficient lubricant must have the following characteristics: (1) Enough body to maintain a film of oil between the rubbing members under the maximum pressure that it will be subjected to; (2) greatest fluidity consistent with condition No. 1; (3) a minimum in the sum of the solid and fluid friction; (4) maximum capacity for receiving, transmitting, storing and carrying away heat; (5) no tendency to gum or decompose while in use; (6) freedom from acids to cause injury to any of the materials with which it comes in contact; (7) a high evaporizing point and low solidifying point; (8) freedom from grit, dirt or other foreign matter; (9) no content of vegetable oils if likely to be taken into the boiler, as vegetable oils will cause corrosion and pitting of the boiler shell.

Oil should be bought under specifications determined by tests, showing the quality needed for each condition. It should be tested as soon as it is received to make sure that it meets the requirements. As an illustration of what an oil test should show, the following figures are given:

COMPARATIVE TEST OF THREE OILS

	A	B	C
Composition	Animal and Mineral	Animal and Mineral	Animal and Mineral
Adulterants	None	None	None
Specific gravity at 82 deg. F.	0.877	0.876	0.892
Flashing point, deg. F.	356	374	410
Burning point, deg. F.	410	424	446
Chill point, deg. F.	—4	—5.8	26.6
Loss at 176 deg. in 5 hr., per cent.	0.99	1.67	1.95

COMPARATIVE VISCOSITY

Temperature	Water	A	B	C
100 deg. F.	9.5 sec.	21.2 sec.	20.8 sec.	37.7 sec.
120 deg. F.	9.5 sec.	17.7 sec.	17.6 sec.	27.0 sec.
176 deg. F.	9.5 sec.	12.7 sec.	13.5 sec.	15.7 sec.
The above is the time to flow through a $\frac{3}{32}$-in. opening of 30 c.c. of oil and water.				
Distance flowed in inches down a glass-plate grade of 3.5 per cent.—time, 2 hours, 15 min.		21½	21½	17½
Coef. of friction		0.0400	0.0416	0.0490

The adulterants usually added to oil are soap, caoutchouc, graphite, soapstone, barytes, free lime, chalk, starch, rosin oil and free acid. Most of these can readily be detected by any engineer by simple tests.

To test for free acid, take 15.4 c.c. of oil and add enough neutral methylated spirit to make 50 c.c., add a little phenolphthalein solution, then add a normal solution of caustic soda until a pink color is obtained; the number of cubic centimeters of caustic soda used multiplied by 2 equals the per cent. of free acid present.

For soap detection, add 1 c.c. of a saturated solution of metaphosphoric acid (powdered acid); if soap is present a flocculent precipitate will be formed.

Caoutchouc is not soluble in a mixture of 3 parts of alcohol and 4 parts ether.

To test for inorganic substances, dissolve oil in petroleum spirits and evaporate. Graphite is difficult to burn; soapstone and barytes are not soluble in dilute hydrochloric acid; free lime gives a red color when phenolphthalein is added; chalk would not, but would efferverse on the addition of an acid. Starch is detected by adding iodine.

For rosin oil, take 2 c.c. of oil and 3 c.c. of acetic anhydride, shake and filter, test filtrate with sulphuric acid (sp.g. 1.53); red color obtained if rosin is present.

After burning oils the following percentage of ash should be found: Machine oils, 0.002 to 0.055; cylinder oids, $.002 to 0.08.

To properly lubricate cylinders the oil should be fed in minute quantities with every revolution of the engine, thereby insuring its atomizing and reaching all the working and rubbing surfaces of the cylinder. The steam, being thoroughly saturated with oil, will give better distribution and results than can be obtained by any other method.

It has often been claimed that adding the various graphite compounds to oil will aid in obtaining better lubrication. This is true for a short time, but the pores of the iron soon become filled and it is impossible to keep any oil in the cylinders. The main bearings on an engine should be lubricated by an oil bath.

In turbine plants very little trouble is experienced in the lubrication of the bearings in the horizontal type of turbines, and where a step bearing is used no trouble is experienced so long as the oil is kept free from water and foreign substances. But in many plants where large quantities of oil are kept in storage and in circulation in the system, the oil becomes very dark in color and various colored muck is obtained. This is very serious and may necessitate rebuilding the whole oil system, for the following reasons:

When turbine oils are exposed to heat, air and moisture in the oil-circulating systems, where two or more metals of decidedly different potentiality are used, such as brass pipe, copper and brass netting in galvanized-iron pipe, the oils are broken up by electrochemical and galvanic actions and reactions and catalytic actions that set in as soon as an electrolyte is formed in the oil system. Some of the products formed by these actions are retained in solution, while others are thrown out in the form of muck. Often it will be noticed that more or less corrosive action will take place in the various metals of the oil system. The oil system should be built entirely of black iron. In many places the cost of lubrication is kept down by installing machines for extracting oil from the waste and towels that are used to wipe up the oil around the turbines and engines. This oil, when filtered, is ready for service again.

It will be found, if a record is kept of the oil used by each shift, that the amount will gradually grow less, and this is the only way to find out who uses the minimum amount of oil.

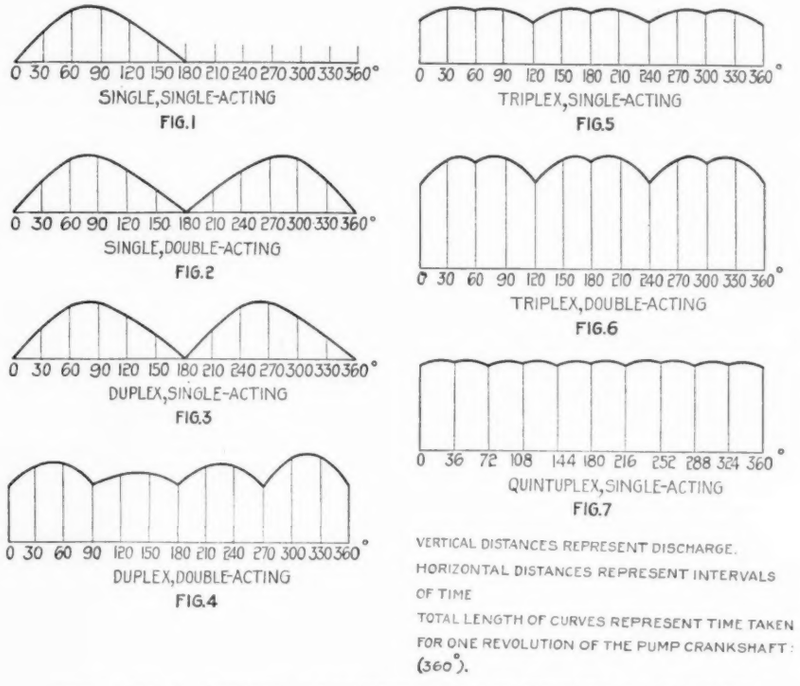
Water Discharge of Power Pumps

By D. Fliegelman

In the selection of a reciprocating power pump, either of the horizontal or vertical type, it is often essential for the engineer to specify the particular type of machine that is most suitable for the service for which it is to be used. It may be a single-acting or a double-acting machine, of the single, duplex or triplex, or even of the quintuplex pattern. The discharge of each pump is peculiar to its kind, sometimes, being more or less uniform.

Conditions may be such that it is necessary to install a pump having a practically uniform discharge. For example, discharging through a long pipe line incurs a friction head. If the discharge of the pump used for this condition is not uniform, the friction to be overcome is that produced by the maximum discharge of the pump at any instant. This friction may be much higher than that produced by a pump of the same capacity, but having a fairly uniform discharge. The pump having the uneven discharge must necessarily be of heavy construction, amply strong to withstand the maximum discharge pressure. This extra amount of friction also greatly increases the amount of power required to run the pump. Moreover, the uneven discharge through a long pipe line causes water-hammer, which may result in breakage, either in the pipe line or in the pump itself. Also, in the case of boiler feeding it is essential to supply the feed water at a practically uniform rate, and consequently a pump should be installed having a discharge as uniform as possible. With these facts in mind, it is well for those interested to have a graphic representation of the discharge of each type of pump.

The curves shown herewith represent the deliveries of various types of pumps for 360 deg., or one complete revolution of the crankshaft. The vertical ordinates repre-


0 30 60 90 120 150 180 210 240 270 300 330 360°
SINGLE, SINGLE-ACTING
FIG. 1
SINGLE, DOUBLE-ACTING
FIG. 2
DUPLEX, SINGLE-ACTING
FIG. 3
DUPLEX, DOUBLE-ACTING
FIG. 4
TRIPLEX, SINGLE-ACTING
FIG. 5
TRIPLEX, DOUBLE-ACTING
FIG. 6
0 36 72 108 144 180 216 252 288 324 360°
QUINTUPLEX, SINGLE-ACTING
FIG. 7
VERTICAL DISTANCES REPRESENT DISCHARGE.
HORIZONTAL DISTANCES REPRESENT INTERVALS OF TIME
TOTAL LENGTH OF CURVES REPRESENT TIME TAKEN FOR ONE REVOLUTION OF THE PUMP CRANKSHAFT: (360°).

FIGS. 1 TO 7. CURVES REPRESENTING DELIVERIES OF VARIOUS TYPES OF PUMPS

sent the discharge and the horizontal ordinates the positions of the plungers, or the angle through which the crankshaft has rotated. It is also assumed that in each case the crankshaft is rotating at a uniform speed.

The discharge curve for single, single-acting pumps, Fig. 1, shows that the pump is discharging during only 180 deg., or during one-half of each revolution. The single, double-acting curve, Fig. 2, shows the discharge for an artesian deep-well pump having a double-acting plunger, so that the pump discharges on both the up and the down strokes. The duplex single-acting curve, Fig. 3, shows the discharge for deep-well pumps of the two-plunger type, wherein both plungers deliver water only on the up-strokes. The two-plunger type of pump is to be preferred to the double-acting deep-well pump having only one plunger, since the latter has only one plunger rod, which is subjected alternately to tension and compression, whereas the two-plunger pump has two plunger rods, one for each plunger, which are subjected only to tension. Figs. 2 and 3 closely resemble each other, the differences being in the location of the high points of the second pulsations due to the opposite effects of the angularity of the connecting-rods.

Discharge Curves for Different Pumps

Figs. 4, 5, 6 and 7 show discharge curves for duplex double-acting, triplex single-acting, triplex double-acting and quintuplex single-acting pumps, respectively. These curves are applicable to the various types of pumps whether they are inside- or outside-packed, vertical or horizontal. The duplex double-acting pump is usually horizontal. The triplex and quintuplex single-acting pumps are almost always vertical and outside-packed. In fact, all the types of deep-well pumps are inside-packed, since it is necessary for the plungers to operate in working barrels.

The discharge curves shown represent the variations from the least uniform to the most uniform discharge of the various types of pumps. In the consideration of deep-well pumping machinery the triple-plunger pump is recommended wherever a uniform discharge is necessary (see curve, Fig. 5). For horizontal pumps the triplex type is to be preferred. For vertical machines the discharge curve for quintuplex pumps, Fig. 7, shows the greatest uniformity, since this curve approaches more closely a straight line. The quintuplex is usually a more expensive machine than the triplex pump, and it is for this reason that the latter, either single- or double-acting, is called for in specifications where a fairly uniform discharge is essential.

Claims have been made by some manufacturers of horizontal duplex double-acting pumps that their machines show a more uniform discharge than triplex pumps. These claims, however, cannot be supported by a comparison of the discharge curves of these two types of pumps (see Figs. 4 and 5).

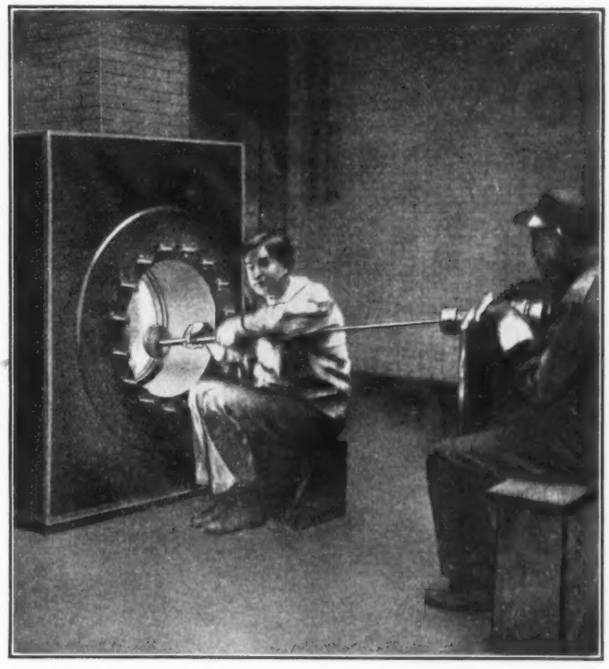
⁂

Solutions for the Orsat may be made as follows: For oxygen, put 1 oz. of pyrogallic acid (powder) into a quart of water, pour in a pint of caustic solution (see solution for CO_2) and immediately seal the bottle air-tight until used. For CO_2, dissolve 1 lb. of caustic potash in 2½ pints of water. For CO, acid cuprous chloride is used. Put a ¼-in. layer of copper oxide in the bottom of a quart jar. Put in a bundle of a dozen lengths of No. 10 or 12 gage bare copper wire cut to length a little less than the depth of the jar. Fill the jar with hydrochloric acid, seal and shake occasionally for 48 hr. Pour off the clear solution and seal it.

Grinding in a Counterbore

The counterbore in the cylinder of a 20x24-in. steam engine did not extend into the cylinder far enough to prevent a shoulder being worn by the piston. It was necessary to extend the counterbore before smooth running could be secured.

To do the job quickly, an ordinary portable electric drill was used to turn a ⅜-in. iron rod. One end of the



HOW THE COUNTERBORE WAS EXTENDED

rod, which was about 5 ft. long, fitted into the drill chuck; the other end carried a ½-in. thick 6-in. diameter emery wheel.

Before beginning to grind, the port openings were stopped up to prevent emery and iron dust from getting to the valves and seats. One man held the drill in position by supporting it on a board V-notched at the top end. A second workman guided the emery wheel to the point requiring grinding. The illustration shows how the job was accomplished. Two men and an hour's time did the trick. The edge of the counterbore was cut practically true by using an old snap ring to assist as a marker in making the shoulder.

While the finished job was not quite so smooth as if it had been machined, it answered the purpose just as well, saved the expense of a boring bar and was quicker.

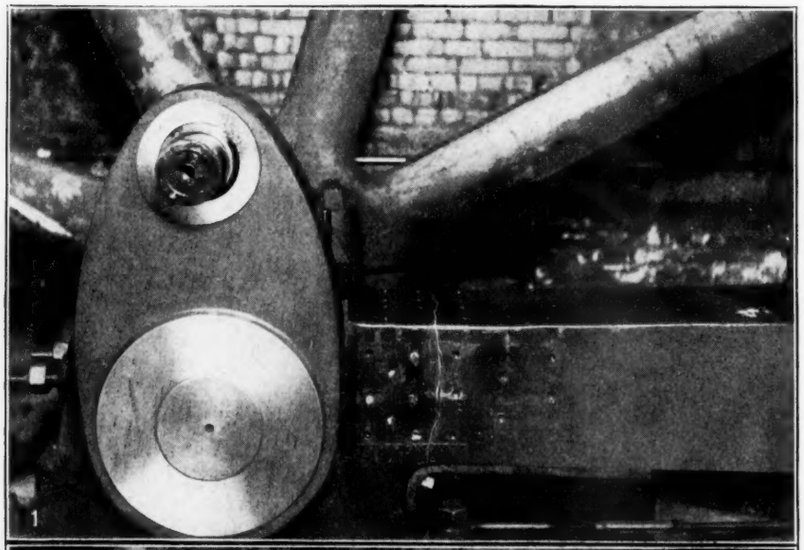
⁂

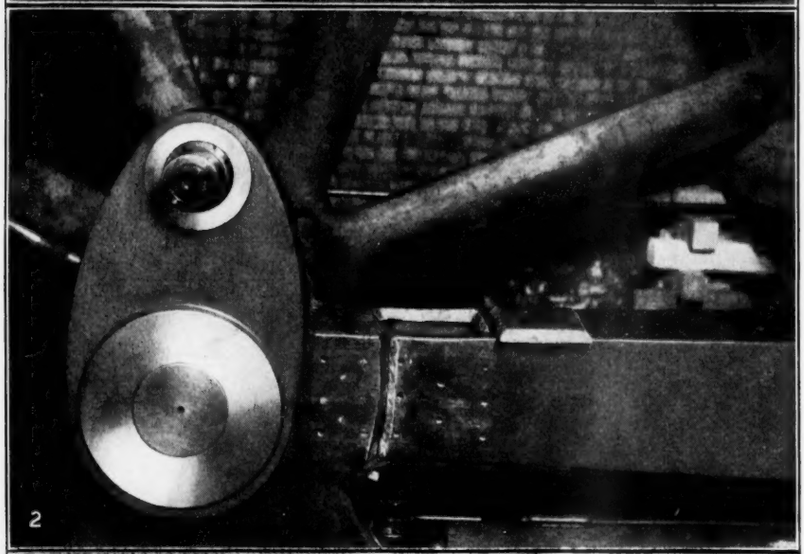
The Mechanism of a Boiler Explosion known as the Colburn Clark theory is as follows: An initial rupture; sudden, rapid reduction in pressure; the formation of a great quantity of steam in the water, hurling the water at the opening, increasing the latter and shattering the boiler; completion of vaporization of the liberated water, projecting the parts to distances depending on the violence of the expansion.

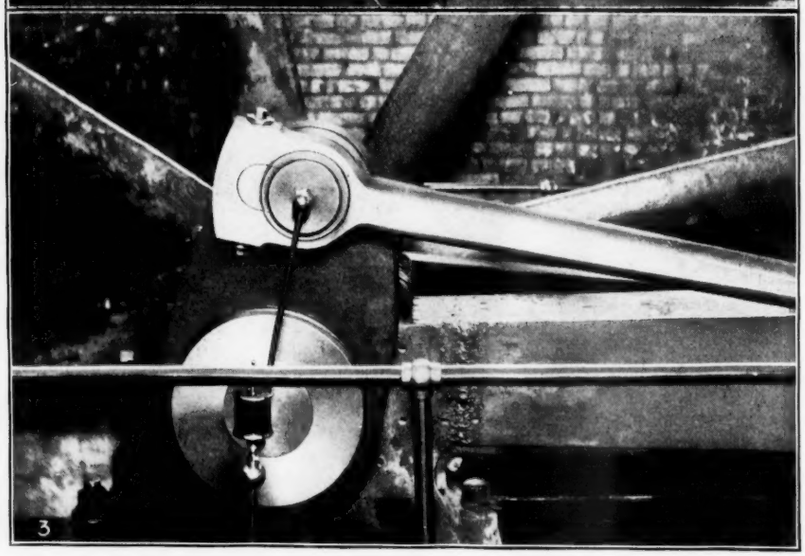
⁂

Laying Up a Boiler—C. E. Stromeyer, chief engineer for the Manchester Steam Users' Association, in his "Memorandum" for 1915 says about laying up a boiler: "To prevent internal corrosion in idle boilers these should be emptied and dried, trays of unslaked lime should be placed inside, and all manholes and other openings should be hermetically sealed. The lime will soon absorb any moisture, carbonic or sulphurous acid that may be in the boiler, and any remaining salt or chloride of magnesia, being dry, can do no harm."

Welding an Engine Frame







FIGS. 1 TO 3. WELDING A CRACKED ENGINE FRAME

Fig. 1—Showing crack in frame and patch bolt holes. Fig. 2—Frame ready for welding. Fig. 3—Frame welded, engine ready to run

SYNOPSIS—An interesting repair job of a cracked girder-type engine frame by welding. The work required the continuous labor of three men for 23 hr. So far as known the frame is as strong as it was before the fracture occurred.

An interesting welding job on the girder frame of a 300-hp. Corliss engine was recently done at the plant of the Hoosier Manufacturing Co., Newcastle, Ind. The engine frame was a hollow cast-iron section about 13 in. square, the metal varying in thickness from about 1½ to 2 in. The crack in the frame was at the crank end, and the frame had been reinforced with boiler-plate patches bolted to it at top, bottom and on both sides. The crack and the bottom plate are shown in Fig. 1, the top and side plates having been removed for the welding. The engine had been run with these stiffening plates for about five years, but with a reduced load from 250 hp., the normal rating, to about 175. At that the crack pulled apart approximately $\frac{1}{32}$ in. with each outward stroke of the engine. As the demand on the steam plant increased to such an extent that the turbines and engines were unequal to the load, it was necessary to repair the engine frame so that the engine could carry its full load. It was decided that welding would make the frame as strong as it was originally, and arrangements were made to begin work immediately after shutting down on a Friday night, so that the engine could be ready for service by the following Monday morning. First the boiler-plate patches were removed except the bottom one (which was difficult to get off and, as it was not in the way, was left on) and a groove chiseled out on both sides of the frame where the crack was. Then a piece about 10 in. square was cut out of the top of the frame so as to get down to the crack in the bottom. The chiseled portion of the frame and the section removed from the top are shown in Fig. 2. Fortunately, compressed air was available for operating an air hammer, which reduced the time in chiseling out the crack from about 25 hr., which would have been required by handwork, to 5 hr. Before beginning work on the frame the connecting-rod was removed, and while the chiseling was going on the engi-

neer jacked the flywheel and crankshaft up on cribwork to get the shaft out of the way of the heat as much as possible and also to remove the bottom segments of the babbitted bearing of the main pillow block to prevent them being injured by the heat.

Chiseling was started at 9:45 p.m., and at 2:45 a.m. the frame was ready for welding. A furnace of loose firebrick was then constructed around the portion to be welded, and at 3:30 a compressed-air and gas heating torch was applied to the frame and left until 6 a.m., when, as the heating was not as rapid as desired, charcoal was placed inside of the furnace underneath the casting itself to help with the heating. At 9:30 the frame was hot enough to start the work.

The bottom crack was first welded, with the torch passed through the hole in the top of the frame. Then the hollow portion of the frame was filled with charcoal to give an even heat, and kept both sides of the frame at an even temperature. The side cracks were next welded, working up slowly from the bottom.

As soon as these welds were finished the charcoal was replenished in the frame and the piece that had been removed was welded in place. The job was completed at 4:15 p.m. The firebrick furnace was then rebuilt and the preheating torch put on the center of the casting for about three-quarters of an hour and the job left with a good charcoal fire inside of the frame, which was protected from the air by the brick furnace. The charcoal received air from the two ends of the frame.

On Sunday morning the frame had cooled enough to permit of placing the hand on it, showing that the reduction of temperature had been gradual, the slow burning out of the charcoal preventing any sudden change. Fig. 3 shows the completed weld and the engine ready to start.

The cost to the owners for the repair complete was $200. The material used on the job, which was done by the Prest-O-Lite Co., of Indianapolis, cost as follows:

Charcoal for preheating	$1.40
Gas and air for preheating torch, estimated	2.00
Cast-iron filling material	3.00
Cast-iron flux	1.00
Labor—three men	21.33
Oxygen, 362 cu.ft. at 2c.	7.24
Acetylene, 330 cu.ft. at 2c.	6.60
Total	$42.57

Incidentally it is interesting to know the cause of the original crack. At the time of the accident the engine was carrying about 350 hp. and taking steam from a battery of boilers that were too small for the work. As a result of these conditions slugs of water were frequently drawn over into the cylinder, and it is believed that these were the cause of the crack, which may have been present for some time before it was discovered.

Test of Motor-Driven Coal-Conveyor System

By L. A. Quayle*

The following test on the coal and ash conveyor installed at the Fairmount pumping station, Cleveland, Ohio, was made to determine whether the motors and conveyor conform with the specifications upon which they were purchased.

The main conveyor, Fig. 1, is of the traveling-bucket type. The buckets are of compressed steel, counterbalanced to hold them in a horizontal position, and they overlap when traveling longitudinally. The cross conveyor, Fig. 2, is of the endless-belt type and conveys the coal from the hopper into which the cars dump (in the space to the right) to the main conveyor, a distance of 10 ft. The ashes are dumped from the boiler ash hoppers into small

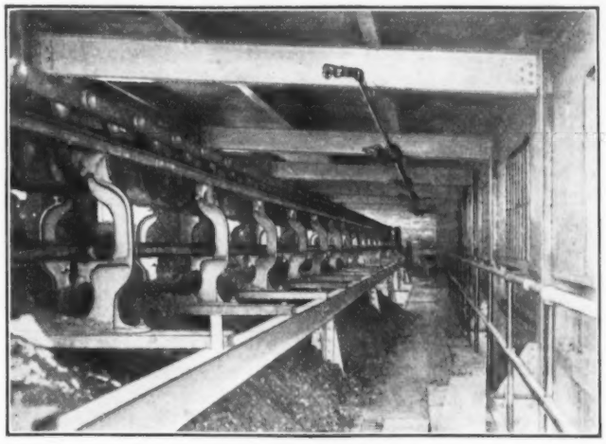


FIG. 1. MAIN BUCKET-TYPE CONVEYOR

cars, which are elevated to the floor above by a hydraulic elevator and dumped into the ash hopper, shown in Fig. 2. From here the ashes are conveyed upward into a large hopper, from which they slide into railroad cars.

Conveyor data and the results of the tests on the conveyor running loaded and also running light are given in the following table:

Total number of buckets in conveyor	173
Pitch of buckets	2 ft.
Total length of conveyor	346 ft.
Total height coal is elevated	55 ft.
Rated capacity of conveyor, tons per hour	40
Speed of conveyor running light	40 ft. per min.
Speed of conveyor running loaded	38.2 ft. per min.
Time required for bucket to return to starting point	9 min. 5 sec.
Type of main- and cross-belt conveyor motors, d.c.,	115-volt compound wound, inclosed
Full-load rating of main-conveyor motor (57½ amperes),	7.25 hp.
Full-load speed of main-conveyor motor	775 r.p.m.
Full-load rating of cross-conveyor motor (19½ amperes),	2.5 hp.
Full-load speed of cross-conveyor motor	1,200 r.p.m.
Length of run, running light	27 min.
Length of run, unloading coal	2 hr. 28 min.
Net weight of coal in car No. 216,435	97,900 lb.
Net weight of coal in car No. 216,082	98,300 lb.
Total coal unloaded	98 tons
Rate of unloading, tons per hour	39.78
Input to both motors, conveyor running light	115 v. 19 amp.
Input to both motors, conveyor running light	2.18 kw.
Current input to both motors, conveyor running loaded,	113 v., 41 amp.
Average input to both motors, conveyor running loaded,	4.63 kw.
Rated continuous input to both motors	8.85 kw.
Actual input in per cent. of rated input	52.3
Max. temp. of bearings on main motor	120 deg. F.
Max. temp. of bearings on cross-belt motor	116 deg. F.
Max. temp. rise of main motor windings	25 deg. C.
Max. temp. rise of cross-belt motor windings	20 deg. C.
Max. allowable temp. rise of main- and cross-conveyor motor windings	55 deg. C.
Theoretical b.hp. required to elevate the coal and give it a velocity of 38.2 ft. per min.	2.22 b.hp.
Efficiency of the conveyor, assuming an efficiency of 80 per cent. for main-conveyor motor and 78 per cent. for cross-conveyor motor	45 per cent.

The conveyor handled slightly less than its rated capacity during the test, owing to the buckets not being completely filled.

The ratio of current input running light (2.18 kw.) to current input running loaded (4.63 kw.) is 47 per cent. which represents approximately the efficiency of the conveyor and checks within 2 per cent. the b.hp. method, which was used in obtaining the efficiency of 45 per cent. shown by the test.

*Assistant engineer, Division of Water.

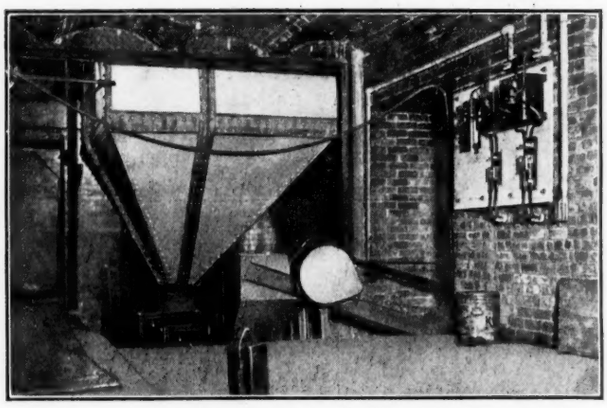


FIG. 2. CROSS-CONVEYOR, ENDLESS-BELT TYPE

The over-all efficiency of the conveyor would have been approximately 4 per cent. greater if the motors had been of such a size that they would have been working at their full-load rating instead of approximately half-load as was the case during the test.

The Banks Boiler-Feed Trap

The boiler-feed trap shown in Fig. 1 is the invention of Joseph H. Banks, chief engineer of the Institution for the Deaf and Dumb, New York City.

Referring to Fig. 2, water from the drainage or other sources enters the spherical chambers through the pipe *A*; one chamber fills while the other discharges. It is to be noticed that the water in chamber *B* must completely fill it before water can get into the float chamber, operate the float and discharge the contents. The float is vented to the atmosphere through its own pipe lever and is therefore likely never to collapse. The ball *D* is hollow and floats on the surface of the water, permitting discharge from the bottom of the chamber. The function of this small float is to prevent noise and vibration.

The large, or lever float operates a pilot D-slide valve *G* admitting steam to a piston, which in turn operates the valve controlling the propelling steam. The double check valve in the discharge pipe simplifies the piping. The pipe *E* is the exhaust. The cold, or makeup, water is admitted through the pipe *F*.

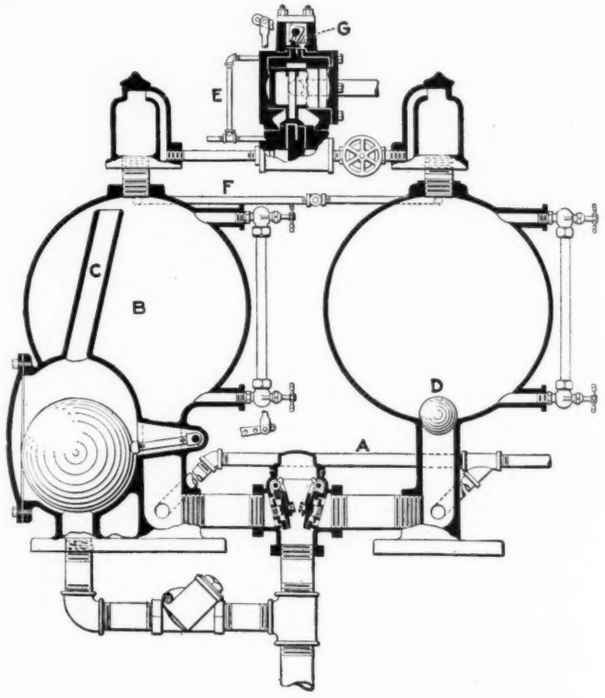


FIG. 2. VALVES, FLOATS AND CHAMBERS

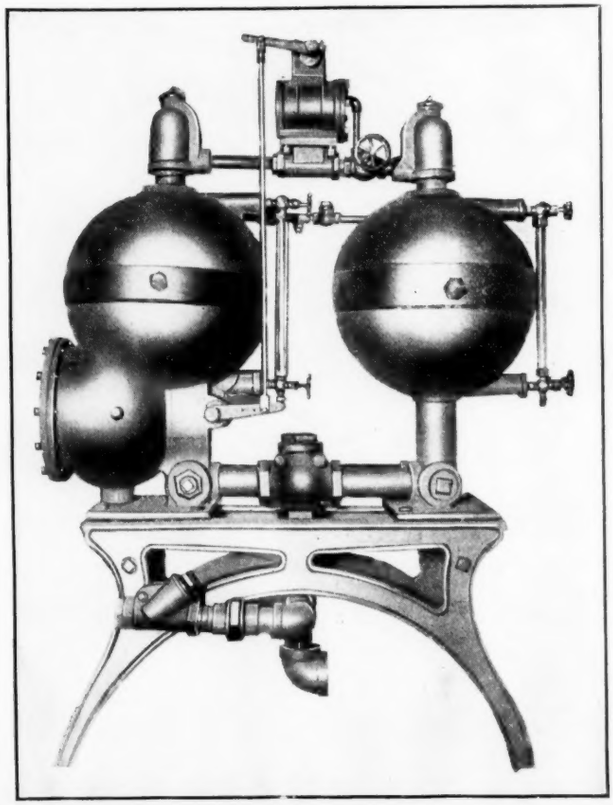


FIG. 1. THE BANKS BOILER FEED TRAP

The trap is sold by John R. Banks, 531 West 159th St., New York City.

An Engineer's Day of Rest (?)

By Thomas G. Thurston

One Sunday morning the day watch came on duty as usual, made the rounds to see that things were right and prepared to take things as easy as possible. Just about when everybody was settled down, there was a hair-raising crash back of No. 2 ice machine and a roar of escaping steam. The oiler scrambled across the frame of the machine to the throttle and shut off the steam.

The cylinder head was found broken into several pieces, but still hanging on the studs, although some of the latter were badly bent. All hands had to get busy, some to pump out the ammonia, others to remove the broken head and others to shut off the steam and exhaust connections. The follower and bullring were considerably broken up, and the piston spider was forced a quarter of an inch up on the rod and away from the nut. At first it was thought that the nut had backed off, but the marks showed that it was in its original position, proving that the piston had been driven in on the rod by being blocked by something solid against the head; but

no evidence had yet been found as to what caused the trouble. It was necessary to take the piston rod out of the crosshead. After trying for some time to drift it out with wedges, the crosshead was heated with a blow torch until it came out easily and the reason for the smash-up was found. The rod was broken off through the eye, or slot for the key, as shown in Fig. 1. When the rod let go, as it probably did at the crank end, it went up against the head with momentum enough to crack the head and follower and when the crosshead came back and the admission valve opened the piston shot forward and the rod was jammed into the crosshead again, where it stuck. On the return stroke some of the pieces from the broken follower caught between the piston and head and drove the piston up on the rod and the rod still farther into the crosshead.

A gang of machinists and helpers was called out and put to work, and the engine-room crew settled down expecting to take it easy for the rest of the day, when the oiler on No. 3 air compressor reported something wrong with the 5,000-cu.ft. air compressor for pumping the wells. The engineer found it had a very pronounced thump as it passed the head-end center and a peculiar jump at the crosshead between the steam and air cylinders when the crank passed the center. It was evident that the piston was striking the head, so he decided that the rod must have backed out of the crosshead and he had it screwed in a part of a turn. On starting up again, the piston struck the other head more violently than it had

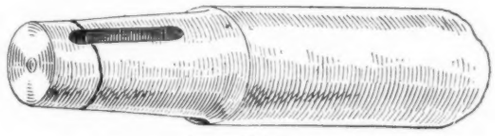


FIG 1.

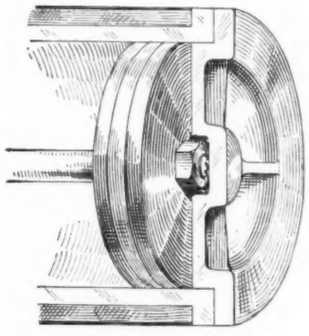


FIG 2.

TWO EVENTS OF THE DAY

the first one. The cylinder head had to be taken off by part of the crew, while others got busy starting up pumps and juggling valves all over the plant. When they got the cylinder head off, they found it and the piston covered with a hard substance much like the carbon deposit in a gas-engine cylinder and a large quantity had been pounded into the recess in the head for the piston-rod nut, shown by the illustration in Fig. 2, and this had caused the thump. The crew "got busy" with scrapers and chisels and removed the deposit.

By this time it was midafternoon, and everybody was tired and settled down to rest for the remainder of the day—but just about then No. 3 ice machine showed signs of distress. It began to race, and there was a terrific pounding at the head end of the ammonia cylinder at the low-pressure side. This time it was nothing more than a broken discharge-valve spring, but everybody had to get busy again, pump the machine out, remove the valve, renew the spring and get started up again. They were still busy when the night shift came in.

Finally, late for dinner, the engineer was gently upbraided when he got home—too dog tired to go out (as per schedule) with wifey, who was first dejected, then waxing indignant, accused him of thinking more of his old power plant than he did of her.

Savings in Percentages

By S. F. Wilson

Engineer No. 1 was a bright enough fellow, but he bent his energies in the wrong direction. He spent most of his time proving that advertisements are "fakes," and this is the way he proved it:

The advertisements stated that the installation of a	Modern engine or turbine would save.....25 per cent.	of the coal burned
	CO_2 recorder would save .....15 per cent.	
	Stoker would save.....15 per cent.	
	Feed-water heater would save .....12 per cent.	
	Soot blower would save.10 per cent.	
	Boiler-scale treatment would save .....12 per cent.	
And he read in the reading pages that plugging the air leaks in boiler settings has been known to save.....10 per cent.		
And nonconducting covering on boilers and piping has saved as much as..... 5 per cent.		
Total .....107 per cent.		

"Preposterous!" he would exclaim; "107 per cent. saved means that I would get a perpetual-motion plant out of it, and that in some strange way or other my coal pile would gradually grow larger instead of smaller."

Engineer No. 1 was finally fired because he couldn't keep up steam. In the "early days" he had no difficulty, but after he started theorizing and disproving the engineering journals, his troubles began. He tried to prove that he shouldn't be fired, but he couldn't do that. So in came Engineer No. 2.

Now the latter was a believer in advertisements and engineering journals, and he told his employers so. He insisted at the very beginning that what the plant needed was a condensing steam turbine instead of the old engine that had worn itself out years ago. The turbine and condenser were installed, and sure enough, in strict accordance with the advertisement, over 25 per cent. of the coal consumption was saved. Roughly, we will call it 25 per cent.

100 per cent. — 25 per cent. = 75 per cent.

Thereafter he therefore used only 75 per cent. as much fuel.

Dissatisfied still, he installed a CO_2 recorder and again, in perfect accord with the advertisement, he made an additional saving of 15 per cent. thereby.

$75 \times 15 = 11.25$ 75 per cent. — 11.25 per cent. = 63.75 per cent.

Next a stoker was installed, and the saving in labor, etc., although it did not directly reduce the coal consumption, amounted to an equivalent of 15 per cent. of the cost of the coal at that time, and can therefore logically be reduced to

$63.75 \times 15 = 9.56$ 63.75 per cent. — 9.56 per cent. = 54.19 per cent.

There is no need in carrying this any farther, for it is plain that Engineer No. 2 had the right idea. He knew

what he was doing. He installed a feed-water heater and got his 12 per cent. saving; a soot blower saved approximately 10 per cent.; cleaning the boiler thoroughly inside and using a suitable boiler compound amounted to a further saving of 15 per cent.; and in following the advice of the editors he stopped air leaks in the boiler setting and used a nonconducting covering on the surfaces that had been radiating heat into the cold atmosphere, giving him an additional saving of 10 per cent. and 5 per cent. respectively.

Extending the computations in the same way as before it will be found that he finally brought the condition of the plant to the point where it used less than 32 per cent. as much coal money as when Engineer No. 1 was running it.

Is this lesson "stretched?" Not a bit. If Engineer No. 2 had begun on the other end and installed the nonconducting covering first, then had plugged up the air leaks, etc., the final result would have been the same mathematically and practically.

Flow of Steam in Pipes

By W. L. Durand

SYNOPSIS—Method of determining the sizes of steam pipes by the use of formulas and by a curve chart by which, if three of the four variables are known, the fourth can be found.

Generally, boilers, engines and accessories are chosen with care, but when it comes to such items as piping, this is either guessed at or designed on the velocity basis, without regard to the factors entering into the flow of steam. Yet what is more important in the design of engineering work than the piping? The commonest method for determining the size of steam pipes is to assume a velocity of 6,000 ft. per min. for high-pressure pipe and 4,000 ft. for low-pressure pipe. That this method will not give satisfactory results, except over a very limited range, may easily be seen if the drop in pressure at these velocities is computed for different sizes of pipe. The accompanying table is based on a length of pipe of 100 ft. and an initial pressure of 100 lb. at 6,000 ft. per min.

Size of pipe, in.	1	1¼	1½	2	3	4	6	8	10
Loss of pressure, lb.	16	10	7.7	5	2.6	1.7	1.0	0.68	0.5

From the foregoing it may been seen that in small pipes the loss in friction is so great as to affect the economy of operation; on the other hand, in the large sizes of steam lines bigger pipes are specified than are necessary. This increases the cost of installation to an appreciable extent since the cost of pipe and fittings increases rapidly with the size.

The factors that enter into any problem of this character are weight or quantity of steam, length of pipe, density of the steam, drop in pressure and the diameter of the pipe. To obtain accurate results, it is necessary to take into consideration all of the foregoing factors, and any formula used in this connection should contain all of them.

The most commonly accepted formula for the flow of steam is Unwin's, which is as follows:

$$W = 87.5 \sqrt{\frac{Dpd^5}{L\left(1+\frac{3.6}{d}\right)}}$$

where

W = Weight of steam flowing in pounds per minute;
L = Length of pipe in feet;
d = Internal diameter of pipe;
D = Density, pounds per cubic foot;
p = Drop in pressure, pounds per square inch.

The reason that this formula is not more generally used is presumably because of the excessive time required in solving it. Recently the writer published a table based on dividing Unwin's formula into three parts. The length of pipe and friction loss may be reduced to one variable "friction loss per unit length," such as "per hundred feet."

$$W = 87.5 \sqrt{\frac{p}{100}} \times \sqrt{D} \times \sqrt{\frac{d^5}{1+\frac{3.6}{d}}}$$

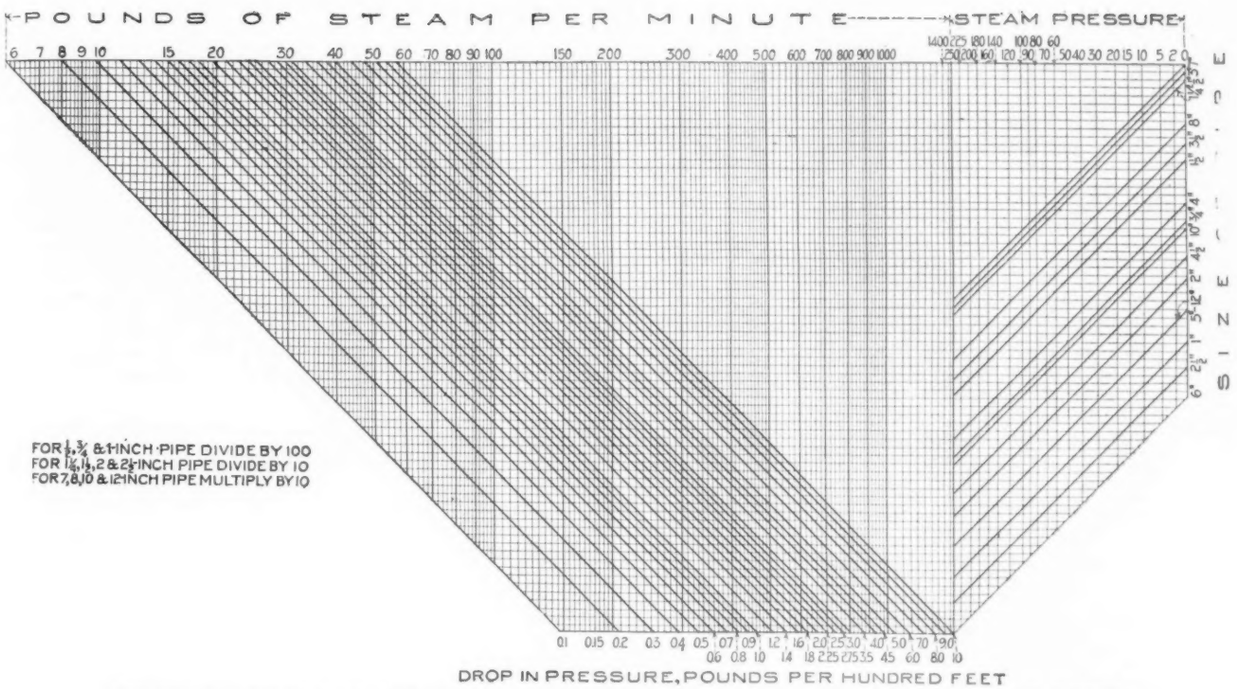
This table is reproduced here to show its application:

Steam Pressure, Lb. per Sq.In.	$\sqrt{D}$	Diameter, Pipe, In.	$\sqrt{\frac{d^5}{1+\frac{3.6}{d}}}$	Drop in Pressure	$87.5\sqrt{\frac{p}{100}}$
		⅛	0.116		
0	0.193	¼	0.262	0.10	2.77
2	0.207	1	0.522	0.15	3.39
5	0.223	1¼	1.170	0.20	3.91
10	0.248	1½	1.830	0.30	4.79
15	0.270	2	3.670	0.40	5.53
20	0.290	2½	6.050	0.50	6.19
30	0.326	3	11.100	0.60	6.77
40	0.358	3½	16.800	0.70	7.31
50	0.388	4	23.500	0.80	7.82
60	0.415	4½	32.100	0.90	8.29
70	0.440	5	43.500	1.00	8.75
80	0.464	6	71.600	1.20	9.58
90	0.486	7	106.000	1.40	10.35
100	0.508	8	150.000	1.60	11.10
120	0.548	10	272.000	1.80	11.70
140	0.585	12	437.000	2.00	12.40
160	0.620	...	.....	2.25	13.10
180	0.653	...	.....	2.50	13.80
200	0.684	...	.....	2.75	14.50
225	0.721	...	.....	3.00	15.20
250	0.756	...	.....	3.50	16.40
...	.....	...	.....	4.00	17.50
...	.....	...	.....	4.50	18.60
...	.....	...	.....	5.00	19.60
...	.....	...	.....	6.00	21.40
...	.....	...	.....	7.00	23.10
...	.....	...	.....	8.00	24.70
...	.....	...	.....	9.00	26.20
...	.....	...	.....	10.00	27.70

If the factors corresponding to the variables in any problem are found from this table and multiplied together, the number of pounds of steam will be directly obtained.

But even this operation may require more time than many engineers desire to spend in sizing pipes. The accompanying curves are based on the foregoing table and give quickly and accurately the result in any problem relating to the flow of steam in pipes if three of the four variables are known.

These curves are really a slide-rule and mechanically add the log of the factors in the table. The log of $\sqrt{D}$ is laid off corresponding to the steam pressure, the log of $\sqrt{\frac{d^5}{1+\frac{3.6}{d}}}$ is laid off for the diameter of the pipe, the


POUNDS OF STEAM PER MINUTE
STEAM PRESSURE
SIZE OF PIPE
FOR ¼,⅜ & ½INCH PIPE DIVIDE BY 100
FOR ¾,1,1½,2 & 2½INCH PIPE DIVIDE BY 10
FOR 7,8,10 & 12INCH PIPE MULTIPLY BY 10
DROP IN PRESSURE, POUNDS PER HUNDRED FEET

CURVES BY WHICH IF ANY THREE VARIABLES ARE KNOWN THE FOURTH CAN BE FOUND

log of 87.5 $\sqrt{\frac{p}{100}}$ is laid off for the drop in pressure, and the log of the quantity of steam is laid off as indicated. This is accomplished by plotting these curves on logarithmic paper.

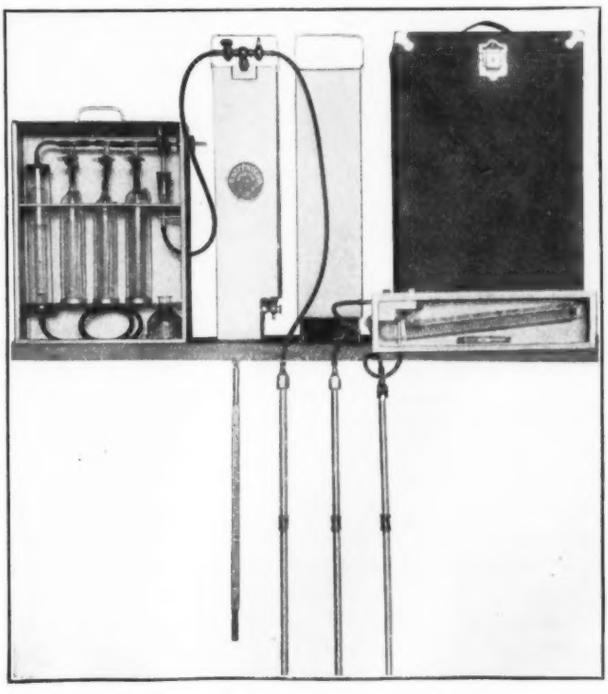
Starting at the pressure line and moving down to the steam pressure desired, the length is proportional to the log of the square root of the density, and by projecting that to the first 45-deg. line, an equal distance at right angles is obtained. Continuing this line to the required pipe size adds the log of the pipe factor. Projecting that distance to the bottom of the 45-deg. lines representing the drop in pressure, a distance equal to the sum of the pressure and diameter is obtained on the vertical scale. By moving up to the required drop the log of the factor for the pressure drop is added, and projecting the sum of the logs of the three factors, the answer is read directly on the quantity scale in pounds of steam per minute.

In order to show the use of this chart, take a hypothetical case of a steam main 800 ft. long and 4 in. diameter with steam at 100 lb. pressure. What will be the flow of steam if the drop is limited to 4 lb.? The drop per 100 ft. is ½ lb. Starting at 100 lb. and running down to the 4-in. diagonal line and over to ½ lb., 73 lb. of steam per min. is read on the "pounds of steam" scale. Suppose the problem to be the same except the pounds of steam given and the drop was to be found. Starting at 100 lb. and running down to the 4-in. diagonal line and over to 73 lb., ½ lb. is found at the intersection. Given any three of the four variables, the fourth can be found from this chart.

Coal Ash Contains Silica, alumina, iron pyrites and other mineral matter. Depending upon the chemical composition and physical condition, these cause the ash to fuse more or less easily. The temperature at which firebrick will melt is sometimes influenced by the composition of the ash. For instance, a certain ash might melt at 2,600 deg. F. and a certain firebrick at 2,800 deg. F.; but together in a furnace both might melt at 2,500 deg. F.

Defender Portable Boiler-Room Test Outfit

A portable boiler-room test outfit that can be supplied in either of the four types of Orsat CO_2 machines made by the Defender Automatic Regulator Co., Oriel Building, St. Louis, Mo., is shown in the accompanying illus-



PORTABLE CO_2 TESTING OUTFIT

tration. It consists of a three-chamber Orsat, a copper two- to three-hour gas collector, a copper water-receiving tank and a duplex differential draft gage. There is also a flue-gas thermometer 16 in. long, in a steel case, reading up to 750 deg. F.

Tom Hunter, Hoisting Engineer

By Warren O. Rogers

SYNOPSIS—Hunter returns to the city, and the engineer of the mine power plant explains how he operates the two barometric condensers without injection-water or dry-air pumps. He also shows that a feed-water heater can be connected between a prime mover and a condenser and cites instances where it is done.

After Hunter had returned to the city, I got chummy with the engineer, who was justly proud of his plant, Fig. 1, which, besides the air compressors, contained two 450-kw. turbines and an engine and a motor-driven 125-volt exciter. The turbines were piped to barometric condensers placed outside the building, Fig. 2. These were shown me by the engineer with evident pride.

"Where are your injection-water pumps?" I asked, having looked for them in vain.

"There isn't any. You see, the water from the mine is of good quality, and as it has to be pumped out of the mine, the discharge pipe is carried to a reservoir on the hill above the plant. From this water-supply the injection water comes to the barometric condensers by gravity. You may not believe it, but we carry an average of 27 in. of vacuum."

"Well, where are your air pumps?"

"Like the injection-water pumps, they are missing. The fact is, both of those condensers run without any auxiliary energy, just using the water that is pumped out of the mine. This is one of the most satisfactory installations I have ever known, and as for the cost of operation, there isn't any outside of the upkeep of the condensers."

"How do they operate?" I inquired, as we stepped outside of the plant.

"About the same as any barometric condenser. The steam enters at the top, and the injection water enters at the side and mingles with the steam coming from the turbine. This mixing of steam and water condenses the former, and the condensate is carried down the tail pipe to the hotwell. In addition to the tail pipe the condenser is fitted with an overflow pipe, with its end sealed in the hotwell."

"What's the overflow for? It seems to me that I've seen condensers operating without them."

"The idea is to take care of any possible flooding, which might damage the turbine. If that type of condenser was working with a reciprocating engine and flooding occurred, the chances are that the engine would be wrecked."

"That's a good idea, especially if in a plant where the engineer might be a little careless. But why isn't it necessary to have an air pump? I supposed one was always used."

"Yes, I know that is the prevailing idea with many engineers, but we carry a vacuum of 27 in., and if the exhaust lines were shorter and air-tight there would be no trouble in carrying close to 28 in. With this kind of condenser the air is forced out partly by the energy of the steam, which you know flows in with a high velocity, and partly by the tendency of the air to cling to the falling water."

"Well, it isn't often that one sees a condensing system operating without pumps of any kind. You certainly have a cheaply operated proposition here. Don't it ever give trouble?"

"Why should it, other than incidentals which occur at any plant? We have no air or circulating pumps and their driving units to bother us, and things move along as quietly as a six-months baby with a nursing bottle. The only trouble one might experience is with the atmospheric relief valve, which may admit air to the condenser unless it is kept water-sealed.

"Another simple cause of air leakage is through pipe joints when rubber gaskets are used in which there is

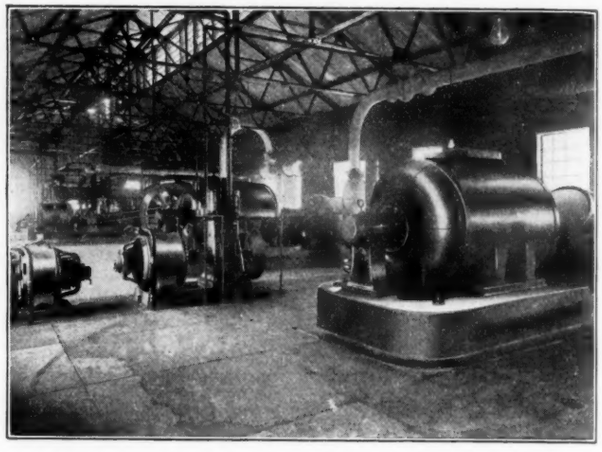


FIG. 1. A VIEW OF THE MINE POWER PLANT

canvas or cloth insertion. You would hardly believe it, but I am convinced that air will leak in through such a joint packing, and because of my belief I always use a solid-rubber gasket.

"Speaking about condensing systems without pumps, I know of one way up in Pennsylvania at a coal mine, with 6,000 kw. in turbine output, besides air compressors. The turbines exhaust into two barometric condensers, each designed to handle 54,000 lb. of steam per hour and produce a vacuum of 28 in. with 4,340 gal. of water per minute at 70 deg. F. With 25 per cent. less water and without an air pump, the same volume of steam can be handled and a 26-in. vacuum maintained; a pretty good record, I think.

"Some engineers make a mistake in operating a barometric condenser. It will not work to the best advantage with more than a minimum amount of water. But you will find when one is first put in operation that the engineer will make the mistake of using too much water, with the result that the throat of the condenser is choked.

"There was a time, and not so long ago, that for engine work and with reasonably cold water, the amount of injection water was not considered much. But when you get to using large, high-vacuum condensers and warm water, the quantity used is important, for two reasons—the cost of pumping it and the volume of air to be handled, most of which comes from the cooling water."

Seeing that the engineer was a talkative chap and understood his business, I decided to get information

regarding operating feed-water heaters in the exhaust line leading to the condenser.

"Why is it," I asked, "that all heaters use the exhaust steam of auxiliaries instead of being piped up to the exhaust line of the main unit; that is, between the turbine or engine and the condenser?"

"Well, there may be reasons with which I am not familiar. Take it in the average power plant; there are enough auxiliaries to furnish all the steam necessary, and more, too, to heat the feed water, which is pumped from the hotwell. Most engineers figure that steam so used is clear gain in so far as the feed water is concerned, but I have my doubts sometimes."

The engineer reached for his corncob pipe which was on the window sill, and motioning me to a seat, for we had reëntered the turbine room, said, after getting a good light:

"I should think that an ideal combination would be to have motor-driven auxiliaries in an electrical plant, with a steam unit to use only when starting up or for emergency."

"How about heating the feed water?" I asked.

"Don't be in a hurry," replied the engineer with a grin, "I haven't finished. The feed-water heater could be connected in the exhaust pipe leading from the turbine or engine to the condenser. Of course it would have to be one of the closed type. I have somewhere around my desk a photograph of one which was taken by a friend." A search brought out the photograph reproduced in Fig. 3.

"There you can see that a heater arranged as shown in that picture uses the exhaust steam from the main unit. It doesn't take up any room in the power plant, and all of the auxiliary apparatus can be motor-operated for general running, and the heater relieves the condenser of some of its work."

"It seems strange the heater isn't covered with some kind of nonconducting material," said I. "It's about the first one I have seen that was not."

"What would be the use? The more steam the heater condenses the less injection water there is to handle. The kind of heater shown is closed. That is, the feed water does not come in contact with the steam, and as the water passes through coiled pipes on the inside of the shell and as the steam surrounds these coils and comes in contact with the shell, the atmospheric conditions do not matter. Of course, the feed-water pipes to and from the heater require protection to prevent the water cooling in coming from the hotwell and in going to the boiler from the heater; but as for using a covering on the heater and the main exhaust pipe, it would be a waste of money."

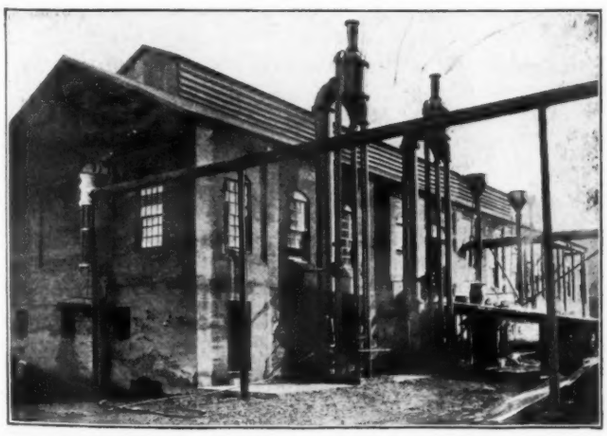


FIG. 2. BAROMETRIC CONDENSERS OPERATED WITHOUT INJECTION OR AIR PUMPS

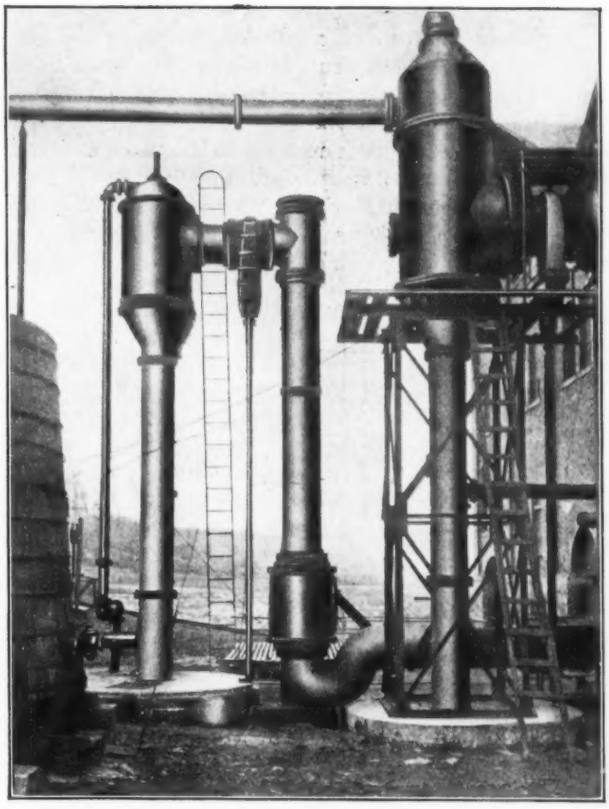


FIG. 3. HEATER CONNECTED IN EXHAUST LEADING TO THE BAROMETRIC CONDENSER

"How is it that more such arrangements of heater and condenser are not installed?" I asked. "I have been in many power plants, but have never seen such a combination. I wonder why?"

"You have me there, old man. Perhaps it is because there are many engineers who don't know a good thing when they see it or, knowing, don't take the trouble to put their knowledge into practice. Most people would rather follow in the old beaten path than to take a side cut and try out something else. That is the reason there are so many 'second raters.'

"I know of a fair-sized steam plant running with a jet condenser and power-driven boiler-feed pump. There isn't a heater in the place. A good deal of steam is used for manufacturing purposes, most of which could be returned for boiler feed, but it is all allowed to go to waste. Of course the water from the condenser goes to the river, and to cap all, the boiler-feed water taken cold from the river, after leaving the power plunger pump, passes through tubes in the furnace before entering the boiler, and coal costing about $4.10 a ton does the work that could be done by exhaust steam if proper provisions had been made."

"How would you have done the trick? Put in a closed heater in the exhaust pipe?"

"No reason why it couldn't be done. Although it isn't what might be called common practice, but you will find them installed here and there. Probably the objection to

be raised is that the exhaust steam at 26 in. vacuum has a temperature a trifle over 126 deg., but most any kind of heater arrangement would be better than heating feed water with coal. I have an old blueprint somewhere about that gives a layout of about what I am driving at."

The engineer again rummaged in his desk and soon brought forth the print reproduced in Fig. 4.

"That arrangement," said he, "provides for two heaters. In the plant where they were installed the exhaust steam from the auxiliaries is not sufficient to heat the feed

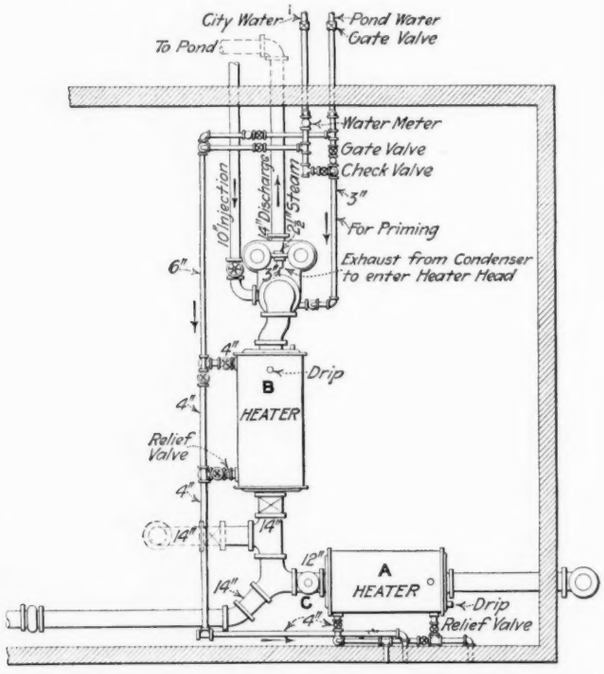


FIG. 4. ARRANGEMENT OF FEED-WATER HEATER IN EXHAUST LINE TO THE CONDENSER

water, and a combination method of using the exhaust steam from the main engines and also from the auxiliaries was adopted.

"Two heaters are used, one being connected in the exhaust line between the engines and the jet condenser, the other placed at right angles to the first and connected to the main exhaust line by a Y-coupling. The other end of the heater is connected to the atmospheric-exhaust pipe.

"Now the exhaust steam from the engines is piped to the heater *B*, and the exhaust steam from the boiler-feed pump goes to the heater *A*. The exhaust from the condenser is also piped to the heater *B*. The idea is that the feed water passes through both heaters and the auxiliary exhaust, after passing through the heater *A*, goes to the condenser. The feed water, after going through both heaters, goes to the boiler at about 210 deg. F.

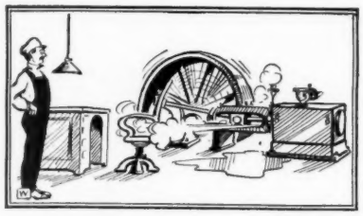
"Each heater is arranged with a bypass, so that either can be cut out of service. By closing certain valves the exhaust steam from the auxiliaries is used for heating a building adjoining the plant, during cold weather. I suppose that there are many other plants where a heater is piped up with a condenser."

By this time the afternoon was well advanced, and not caring to find myself wandering about the mines after dark, I left my friend and was soon at the hotel.

JUST FOR FUN

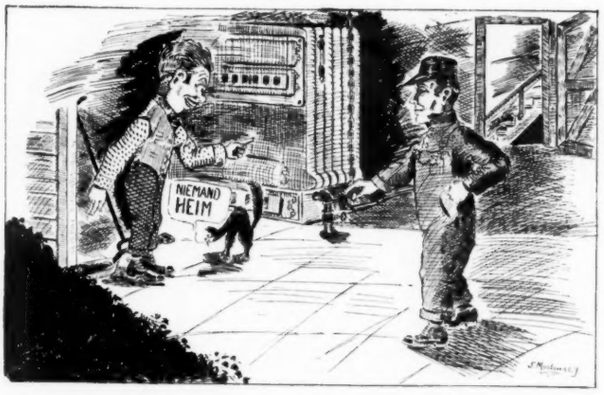
Why Louie Packed the Engine

Burt, the oiler, noticed when he came on duty in the morning that one of the engines needed packing badly on the piston rod and brought this to the attention of Louie, the engineer, who said he would leave it to the night man, as he would have the engine down anyway. The engine blew away until noon, when Louie decided to shut it down, which he did; and when Burt asked him why he had concluded to pack it, Louie replied, "Why the blamed thing was squirting water all over my chair."—M. C. Skinner, Mayville, Wis.



Why the Water Was Dirty

When the small heating boiler was started up at the beginning of cold weather, the night clerk in the office complained that the boiler did not give off enough heat. He watched the night foreman blow down the boiler one night, the water coming out black and dirty. He also noticed that soft coal was being used instead of hard (a case of emergency) and exclaimed, with a knowing shrug of his shoulders, "No wonder you've got black, dirty water in that boiler. Why wouldn't you have, using that soft coal."—John Muldowney, Hudson, N. Y.



"NO WONDER THE WATER IS DIRTY, USING SOFT COAL"

This Engineer Knew His Job

A so-called engineer of a traction engine had an unusually hard pull up a steep hill, and as he reached the top the fusible plug melted, owing to the inclined position of the boiler. A real engineer arrived just in time to see the "so-called engineer" start unscrewing a 1½-in. plug in the steam dome, so as to relieve the 50 lb. pressure still on the boiler. "Say," said he, "you had better wait until the pressure is down before you take out that plug"; whereupon the traction engineer retorted, "I guess I've run an engine before." He kept right on, when "bang" went the plug and left for parts unknown.—Frank Gartmann, Milwaukee, Wis.

Editorials

Entertaining One's Predecessor

When an engineer newly in charge of a plant receives a visit from his predecessor, it is apt to be interesting. Just what kind of a visit it proves to be depends usually upon the temperament of the former chief. There is no reason, however, why the present head of the plant need concern himself unduly over the views and opinions of his predecessor except to derive what benefit he can from them and to treat the former incumbent with every reasonable courtesy.

It is a great temptation for a man who leaves a plant, perhaps under real injustice, to unburden himself to his successor, but generally speaking, the game isn't worth the candle. The wise chief will listen appreciatively to the experiences of his predecessor and try to turn the conversation in directions that will be of some real help in operating the plant, but he will find ways of avoiding listening to tales of woe regarding the "boss." Anything that throws light upon the peculiarities of the equipment is one matter, and aspersions directed toward one's present superior are another. There is mighty little good from being the recipient of confidences bearing upon the general "cussedness" of the superintendent or manager; but a whole lot may be learned by tactful treatment of one's predecessor if he is a man of ability and good sense.

Having worked in a plant perhaps for years, the former chief naturally feels at home in it and possibly tends to make himself a little too much at home now and then when he revisits the place. An engineer with due consideration for the regulations and for the views of others will not take such liberties without asking. How far hospitalities may extend depends upon the man in charge, and old employees who deserve the freedom of the station usually get it without asking, when the new chief is an individual of discernment.

It is remarkable how quickly a previous chief engineer will "spot" changes instituted by his successor, either in personnel or in the equipment. It is human nature to view such changes rather skeptically, but the succeeding chief should never adopt an apologetic attitude for modifications that he has introduced, nor should he feel obliged to explain the reasons for them. Because even a very able man has operated a plant before such a visit, the new chief is in no wise bound to justify his course to his predecessor. Every engineer has his own ideas and very properly likes to put them on trial, and even where certain combinations of equipment or certain schemes of operation are clearly working out unsatisfactorily, the present chief need feel no embarrassment. These things are between him and his superior, and although it is natural to feel a bit diffident before the keen scrutiny of one's predecessor, if he be a man of considerable reputation and perhaps one who has risen since leaving the plant, the right way to take such scrutiny is clear. It is simply a case of being willing to learn from every possible quarter, but of reserving judgment until the time comes for action.

A tour through the plant in company with a former chief who is a man of ability and engaging personality, who appreciates that improvements may have been made since his own time and who is ready in a friendly way to help with suggestions and even with constructive criticisms, is a real opportunity. It is a very different matter from going over the installation with a sorehead and letting the latter vent his disgruntled feelings on the plant and its owners. Where the relations of the former chief are friendly and where his visit is a welcome event, the mutual benefits of an occasional call are worth all they may cost in time and courtesy to both parties.

⁂

Mr. Bolton's Boomerang

At last the important—dollars and cents—results of the famous Hall of Records test are available.

For nearly two years the eyes of those interested in power-plant operation have been strained looking for the report of the board that conducted this test. The plant furnishes light, heat and power not only to the Hall of Records but to the City Hall, City Court and County Court, houses as well. The test was to determine if this service could be supplied more cheaply by this plant than if the New York Edison Company supplied the current while steam was generated on the premises and paid for by the Edison Company. This test, which was run for a year, was the most important scientific investigation of the comparative merits of central-station and isolated-plant service for a given group of buildings ever conducted.

As has several times been mentioned in *Power,* the test was conducted by Prof. Herman Diederichs, of Cornell University, under the direction of Prof. R. C. Carpenter, of Cornell, and Prof. Charles E. Lucke, of Columbia, representing the Borough of Municipal Research; E. P. Goodrich, consulting engineer to the Borough of Manhattan, and Prof. George F. Sever, of Columbia, representing the Borough of Manhattan; and R. P. Bolton, consulting engineer, and E. F. Tweedy, commercial engineer, of the New York Edison Company, representing that company.

One must not for a moment underestimate the moral effect on the business man of the reported results of this test, no matter which side is favored. The psychologist can tell you that first impressions are strongest and not easily convincingly refuted. Knowing that in this most extensive of tests it was beaten despite compromise after compromise by the others of the board, and rightfully chafing under the delay in the publication of the results, the New York Edison Company ordered its Mr. Bolton to prepare and publicly distribute a report, which he did, and this report was fed to the unsuspecting daily press.

For cleverness the report and the newspaper story constitute a masterpiece. But by that we do not mean that Mr. Bolton has falsified the figures. He has not. But the uninitiated reader never would suspect but that the

story was that of a report in which the whole board had concurred and that the conclusions in Mr. Bolton's report are the conclusions of the whole board. But they are not. They are only those Mr. Bolton felt obliged to show for his client.

The test had progressed far enough to demonstrate that at the existing rate for current the Hall of Records plant was doing better than the Edison Company could do. So the company offered to guarantee to furnish light, heat and power for thirty-five thousand dollars a year, which would mean a much lower rate for current than the existing one. The test showed that it cost approximately thirty-nine thousand three hundred dollars a year with isolated-plant service. Mr. Bolton's report states that with Edison service the cost would be a little over thirty-two thousand dollars a year. But—and here is the cleverest part of it all—this last sum is not based on the existing rate as the unsuspecting would suppose, but on one much lower—lower than other citizens are paying for similar service.

The report of counsel for the Borough of Municipal Research shows that to equal the Hall of Records plant the Edison Company would have to furnish current for one and six-tenths cents per kilowatt-hour, and that "changes in the plant equipment and piping might be made that would produce more favorable conditions for municipal operation, as would also any addition to the load on the plant by adding the service requirements of neighboring city property." The guarantee of a sum not greater than thirty-five thousand dollars per year is a sop to the city. As a matter of policy the situation is reduced to this: Should the city accept a discriminative rate, thereby putting itself in collusion with the electric corporation to enable the latter more easily to get business from the citizens by advertising the city as a notable customer, but saying nothing about serving it at a sacrifice and for a rate which citizens could not enjoy?

There is little doubt that many will contend that if the electric corporation is willing to lose money to have the city a customer in this matter, the city would show poor business judgment not to sign the contract. But this statement is only another way of saying that rate-making and the regulation of business should be thrown to the four winds. Volumes of discussion, many legal decisions and libraries of data have been developed in showing that any public-utility company should not be allowed to make any rate, high or low, that it chooses regardless of the effect on the community. And the rate that the electric corporation would have to make for the Hall of Records group service would be below that which a conscientious public-service commission would allow. The question of rate—of allowing or not allowing the Edison Company to make one low enough to surpass the excellent showing of the Hall of Records plant—is likely to be the main one on which the fight will hinge. The Edison Company has invested ten thousand dollars as its share in defraying the expenses of the test. It has much to gain by winning and much to lose by losing. It may be expected to fight long and hard.

It was seen to that Mr. Bolton's report was circulated widely and put before many owners and managers of isolated plants. Engineers owe it to themselves to see that the true situation as set forth in this editorial and in other publications is given the same wide circulation.

Boiler Explosions for the First Half of 1915

The table of boiler explosions (page 342) for the first half of 1915 (January-June), while not as full and complete as could be desired, records only 101 explosions or failures of all kinds, and the estimates of property losses total $69,530. Forty-six lost their lives and eighty-nine were more or less seriously injured. While the number of accidents and the total damage done are below those of previous times, the fatalities and injuries seem out of all proportion.

A striking feature is that of a vertical boiler rated at ten horsepower and supposed to carry only sixty-five pounds' pressure causing a loss amounting to $25,000, through fire as a result of the explosion. State license or compulsory-inspection laws seldom include boilers of this size. Accidents like this serve to show that such exemptions are wrong, and even if a little boiler could do only a little damage, why exempt it?

About one-fifth of the explosions were of house-heating or water-heating boilers on which the pressure is low as a rule and they are not considered worthy of inspection. It is true that the failures in proportion to the number in use is not great, but they come "close home."

The best of inspection and supervision is none too good for any vessel containing steam under pressure.

⁂

A Dangerous Power Bill

There is grave danger that questions of preparedness and foreign relations may overshadow water-power legislation at the present session of Congress to the extent that no action will be taken or that the pending bills will be garbled so as to destroy all vestige of protection to the public.

Of the devious moves of the water-power interests, by far the most subtle is the measure reported by Senator Myers as a substitute for the Ferris bill. This, as pointed out on page 343, would have the effect of tying the Government hand and foot, and at some future date the people would find themselves face to face with a situation in the power commodity similar to that now existing with regard to coal and gasoline.

⁂

The chief engineer that courts death and injury by taking chances has not familiarized himself with the workmen's compensation law in his state.

⁂

If you can survive the ecstasy, contemplate being an engineer when these higher steam pressures do away with gaskets.

⁂

Massachusetts has reasons to be jealous of her reputation—she was the first to have a boiler law and is first with a refrigeration safety law. Good old commonwealth!

⁂

Water power over-developed in the West.—News item. Flooded, as it were.

⁂

The scarcity of Russian oil is one indication that commerce is not running smoothly.

⁂

Some day someone will invent a regulator to regulate the automatic regulator.

Correspondence

Incompetence and Carelessness

One frequent cause of accidents—I almost said the most frequent cause—is haste due to the necessity for securing the same results, time included, as have been obtained by others who have neglected "safety first." An open light or torch is lowered into a tank that has just been emptied of oil and steamed, but not thoroughly. Why? Because the deceased was in a hurry and the time required to thoroughly steam it or get an electric light or pocket flashlight would mean delay. Why was he in a hurry? To save his employer his wages or to get the tank back into service sooner? Theoretically the latter perhaps, but probably he had lost a little time somewhere on the job and sensitiveness over having it appear that he was not "holding up his end" caused a feeling of haste, and he took what he thought was a small risk.

Another cause of accidents is failure to properly instruct the men. In one plant where an accident occurred, it happened that the necessity for getting the boiler back into service caused a nervous haste that resulted in ordinarily careful men overlooking usual precautious. Why the necessity for haste? Because the oft-recommended reserve boiler had never been added to the overloaded boilers in service.

In interurban- or steam-railroad service there may be a slow order on a certain bridge or on a curve where the track is undergoing repairs. But the engineer is expected to make certain time. Other trains have made the time, and no train crew is on record as having stated that they were obliged to disobey orders to do it. In one case investigated it was found that a few little details had caused delay and the engineer had hit the curve a trifle too fast. At least that is the easiest way of accounting for it, and therefore that is the coroner's opinion. It is perfectly true that the engineer had no business trying to make up time—many engineers would not. But it is also true that a delay-report essay recounting a lot of little details—a small delay for baggage and an emergency application of the brakes when an automobile barely crossed the track in the clear, and others—would look to the trainmaster like "anything for an excuse."

While nothing is more true than that many serious accidents can be indirectly traced to the extreme reluctance of the employer to hiring competent men (their wrong methods often relieving the employer of legal accountability), accidents sometimes happen to men of experience. Some things are "purely psychological." The question is, why the tense psychological or mental state? Has the attitude of some (not all) employers toward the occasional legitimate delay anything to do with it?

If it were possible it would be extremely interesting to know what proportion of the total number of accidents (or of some representative list of accidents) was due to methods which at other times the operator knew better than to use. Perhaps some reader with accident-insurance experience could give us some figures, or an opinion.

Oakland, Calif. S. Wilcox.

Piston Rod Broke at Crosshead

Tuesday, Jan. 25, 1916, a 3⅛-in. diameter piston rod on the 20x40-in. engine in the Parsons Pulp and Lumber Co.'s sawmill, Horton, W. Va., broke in the crosshead, smashing the cylinder head into 17 pieces and breaking off five 1⅜-in. stud-bolts made of Norway iron. The piston and follower knocked out a part of one end of the engine room. This engine carried a 14-ft. flywheel and ran at 96 r.p.m. No one was hurt, as the engineer was outside of the mill trimming arc lamps.

Two years ago this engine broke in the crosshead and did about the same amount of damage. The engineer was out of the engine room at that time also, and no one was injured.

The engine is old, the builder's number being 33. Several weeks ago it was wrecked by water, the steam chest being broken. As the piston rod had a flaw or an old break in it where it broke off, it is possible that when the water damaged the steam chest, it also cracked the piston rod, although it has been pulling full load every day since. This piston rod has no nut to lock it against the crosshead. The latter is made in two pieces and is clamped on the rod with two bolts after the rod is screwed in place. W. N. Behen.

Horton, W. Va.

Showing of the Cleveland Municipal Plant

In reference to the showing of the Cleveland municipal light plant, as discussed in a letter by Mr. Reginald P. Bolton in the Feb. 8 issue, I would say that Mr. Bolton is in error in the assumption that a depreciation of 4 per cent. in addition to the fixed charges should be allowed. The whole question of depreciation is one that has never been settled, and there are probably no two people in the country who agree as to the percentage that should be set up for depreciation or what should be done with the money that is set aside for this purpose.

The findings of state utility commissions, as well as the decisions of the Supreme Court in rate-making and purchase cases, present a wide divergence in respect to this question. The private companies engaged in the electric-lighting business in this country do not set up a redemption fund for the purpose of redeeming their bonds and capital stock and other securities representing their investment. As a matter of fact, their investment is always carried as a perpetual liability; therefore, when we set up a redemption fund for the purpose of liquidating our bonds when they mature, we are doing something that the private corporations do not do. If, in addition to this, we not only spend money for repairs and maintenance, but also invest our surplus earnings in additions and extensions so that the total investment in our plant is continually growing in value, we are then doing considerably more, as far as taking care of depre-

ciation is concerned, than the private corporations that pay out most of their earnings in dividends.

I have delayed sending in this communication until the final figures showing the results of the Cleveland municipal lighting plant for the year 1915 were available, and I now take pleasure in presenting herewith tabular statements showing the interest on the outstanding bonds and the payments necessary to maintain a redemption fund to pay off these bonds when they mature, together with a statement as to the actual amount of money paid from the profits of the Municipal Lighting Department during the year 1915 to apply on these items.

Statement of Bond Interest

Bond Name	Amount	Rate Per Cent.	Date of Maturity	Interest Annually
Brooklyn	$30,000.00	5	Mar. 1, 1922	$1,500.00
Collinwood	18,000.00	4	Jan. 1, 1915	720.00
Collinwood	22,000.00	4	Apr. 1, 1916	880.00
E. 53rd St.	500,000.00	4	Apr. 1, 1947	20,000.00
E. 53rd St.	200,000.00	4	Apr. 1, 1947	8,000.00
E. 53rd St.	500,000.00	4½	Apr. 1, 1947	21,250.00
E. 53rd St.	800,000.00	4½	Mar. 1, 1949	36,000.00
E. 53rd St.	500,000.00	4½	Dec. 1, 1939	22,500.00
E. 53rd St.	200,000.00	4½	Dec. 1, 1939	9,000.00
Totals	$2,770,000.00			$119,850.00

Statement of Redemption Fund

Date of Maturity	Amount of of Bonds	Annual	
April 1, 1947	$500,000.00	$7,049.50	
April 1, 1947	200,000.00	2,793.90	
April 1, 1948	500,000.00	6,701.40	
March 1, 1949	800,000.00	7,939.12	
March 1, 1922	30,000.00	3,682.20	
April 1, 1916	22,000.00	10,466.30	
January 1, 1925	18,000.00	1,430.50	
	$2,070,000.00		$40,062.92
Serial Bonds			
December 1, 1939	$500,000.00	$20,000.00	
December 1, 1939	200,000.00	8,000.00	28,000.00
	$700,000.00		$68,062.92

Interest paid from earnings, March 31, 1915	$27,152.50
Interest paid from earnings, April 30, 1915	40,000.00
Interest paid from earnings, September 1, 1915	20,678.37
Interest paid from earnings, September 30, 1915	25,065.00
Interest paid from earnings, November 30, 1915	15,750.00
Interest paid from earnings, December 20, 1915	405.00
Total paid from earnings	129,050.87
Accrued interest to credit light plant	32,125.84
Total credit to light plant	$161,176.71

Under the "Statement of Bond Interest" it is shown that the total interest on the light bonds amounts to $119,850 per year, and according to final tabulation we actually paid out of earnings $129,050.87 and in addition were also credited with accrued interest to the amount of $32,125.84, making a total credit of $161,176.71 during the year 1915. In addition to this, however, the Municipal Light Department owes to the Sinking Fund Commission interest on bonds amounting to the sum of $70,463.29.

This represents interest on the bonds during the construction period of the plant, when it was not making any money. We would have been justified by customary practice in paying this $70,000 interest on our money before it began to earn a return from our bond money and charge it to capital account, but since we knew that the plant within a year or two would be making ample profit to pay this back interest from earnings, it was thought best to borrow the money from the Sinking Fund Commission, paying interest until such time as the profits of the plant would enable us to pay it off. In this way this money was available for connecting up more customers.

During the year 1915 we also paid to the Sinking Fund Commission $68,062.92 to apply on the redemption fund, as shown, which was the amount necessary to be set aside annually to redeem the bonds when they mature.

The Municipal Light Department made such a good showing during 1915 that not only were the payments necessary for the interest and redemption fund made, but we also repaid to the Water Works Department $53,000 from our profits. This cleaned up everything we owed to the Water Works Department, including the $35,000 that was borrowed for the Division Street generators, with interest.

The lighting plant started in the first of the year 1915 with a load of only one-fifth of its capacity and at the end of 1915 was only a little over one-half loaded, so that with efficient management, the surplus for the year 1916, should be considerably more than it was for 1915 and the $70,000 interest on the bonds during the construction period can easily be paid, thus wiping the slate clean and leaving the way clear for a large surplus of profit every year thereafter in addition to the payments necessary for interest and redemption fund.

The total revenue for the year 1915 was $541,495.98; the total operation and maintenance cost was $311,135.23; the total output of the station for the year was 29,426,760 kw.-hr.; the number of kilowatt-hours actually sold to customers was 25,815,399, representing a loss in transmission of only 12½ per cent.; the cost generated at the switchboard for operation and maintenance was 1.057c. per kw.-hr.; the average sale price for all current sold was 2.048c. per kw.-hr.; the maximum charge to any customer was only 3c. per kw.-hr., and the minimum was 0.89c.

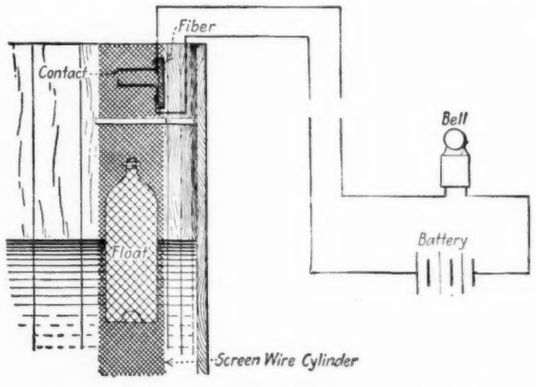
On Dec. 31, 1915, we had 15,514 customers, and out of this number there are less than one hundred that are large power users and that get a rate at less than 3c., so that our rate is to all practical purposes, as far as lighting and small customers are concerned, a uniform one of 3c. per kw.-hr.

F. W. BALLARD.

Cleveland, Ohio.

Novel and Reliable Tank Float

The illustration shows an efficient, cheap and reliable telltale for water tanks. It consists of an ordinary quart bottle in a screen-wire cylinder, a bell and battery. The bottle makes a good float, and the screen



GENERAL ARRANGEMENT OF TELLTALE

keeps it in the proper place, so that when the water lifts the bottle it will bring the contacts together and close the circuit. This may not be a new kink, but it was new to me when I found it in use in this plant.

Laredo, Tex. H. R. ROCKWELL.

Is Lime Good Belt Treatment?

I notice in the issue of Feb. 8, page 191, that W. F. Schaphorst criticizes my treatment of an oily belt—putting on a little lime while it is running. The old adage that the proof of the pudding is in the eating holds good in this case, notwithstanding the comments. I should have headed the letter, "Trouble with an Oily Belt," but being a vertical one, it naturally would be more apt to slip and get hot than one that ran in a horizontal position.

I have been expecting that someone would have comments to make in *Power,* as I have had several letters from engineers and some from manufacturers of belt dressing. I am not at all prejudiced against belt dressing—we use a lot of it about the mills, and I have used the products of different makers in other places for over 30 years with good results—but in this particular case neither dressing, castor nor neat's-foot oil would do. The belt runs between two large bearings, and more or less oil is thrown on it all day, and when the load comes on in the evening, trouble begins. A little lime will quickly neutralize the oil, and the belt is all right for the evening run.

As stated in my letter, it drives the dynamo that lights the mills. Of course lime is injurious to leather, but by the time the oil is all absorbed the life is out of the lime and no harm is done. F. P. KINDER.

Saxonville, Mass.

Regarding the criticism of Mr. Kinder's use of lime on belts, pulverized lime is very good where the belt is wet with oil or water. Pulverized chalk, phosphate dust, cement, fireclay or fine ashes will do as well; the idea is to get the dust to absorb the oil or moisture, after which the oil-laden dust is easily scraped off the belt or pulleys. It will sometimes roll up in balls and drop off of its own accord.

Linseed oil is good for cotton or canvas belts, either woven or stitched, especially in damp places or warm climates. Neat's-foot oil is good on leather belts and also on canvas or cotton belts in dry places.

Ringwood Manor, N. J. A. A. BLANCHARD.

Air in Compression and Expansion

In C. K. Bennett's article, "Air in Compression and Expansion," which appears in the issue of Feb. 8, 1916, page 177, the statement that "in the compression of air all the work done is converted into heat and shows itself in the temperature of the compressed air" is incorrect. During isothermal compression its temperature remains constant and the work done is entirely converted into heat, which, as fast as it is produced, is lost through the cylinder walls to its surroundings; but this is the only type of compression in which the work done is completely converted into heat.

In adiabatic compression all the work done shows itself as an increase in temperature of the gas, since no heat is either added to it or lost to its surroundings.

In practice the work done on the gas is partly converted into heat that is lost to the surroundings, and the rest of it is evidenced by an increase in the gas temperature.

Mr. Bennett would lead one to believe that the exponents 1.41, 1.35 and 1.25 are all equal to the ratio $C_r \div C_v = K$. As a matter of fact, only the first one, 1.41, is equal to this ratio, being $0.2375 \div 0.1689 = 1.406$ for air. The exponents 1.35 and 1.25 do not "express the ratio of specific heat at constant pressure and constant volume" for air. HAZEN G. TYLER.

Brooklyn, N. Y.

The first sentence of Mr. Bennett's article is decidedly incorrect. Of course, during strictly adiabatic compression all of the energy expended is stored in the air itself in the form of heat, but the actual compression of the air is only a portion of what the compressor does. It first draws into the cylinder a charge of atmospheric air. During this suction stroke the atmospheric pressure helps the motion of the piston, since, whatever the opposing forces may be, it is easier to move a piston with atmospheric pressure behind it than with a vacuum behind it. Having drawn the cylinder full of atmospheric air, the piston returns, compressing the air. It is true that during this part of the stroke the work done is converted into heat stored in the air or transferred to the jacket water and surrounding metal parts. But this is by no means all of the so-called "compression" stroke. After the air has been compressed to the discharge pressure, it must be discharged from the cylinder against the approximately constant pressure of the receiver. The work done during this part of the compression stroke may exceed that done during the period of actual compression, and further, this work of discharging the air at constant pressure is done against external opposition and is thus entirely used up in overcoming this resistance. In consequence this work is not converted into heat stored in the outgoing air and does not raise the temperature of this air, assuming a perfect compressor and a receiver of great volume and neglecting friction. The work done in compressing air in the ordinary type of compressor is by no means all converted into heat stored in the outgoing air.

Mr. Bennett tells us that his chart "is based on air at atmospheric pressure and an initial temperature of 60 deg." He then assumes that atmospheric pressure is 14.7 lb. per sq.in. This may lead to confusion, if serious use is made of the chart. Although 14.696 lb. per sq.in. is the so-called "standard atmosphere," it is the mean atmospheric pressure at sea level, and it is very rare that we find it exerting exactly this pressure; and at moderate elevations above sea level such a pressure is unknown. Many air compressors are used at high altitudes, where the atmospheric pressure may be as low as 10 lb., so that the chart will give highly erroneous results in such instances.

Three different values appear "for the given exponents representing the ratio $C_p \div C_v = K$, [which] express the ratio of the specific heat at constant pressure and constant volume." Since these specific heats are substantially constant throughout the range of compressor conditions, it is difficult to see how their ratio can have three different values. The ratio of these specific heats is close to 1.4037 for air. (Other gases do not have the same value.) This value is the exponent to use for a true adiabatic expansion or compression. For changes that are not true adiabatics, it has been found that the substitution of another exponent will give an equation that will describe the change, with satisfactory accuracy, but it is by no means correct to say that these modified values of the exponent are different values of the specific-heat ratio.

Later in the article it is said that "the theoretical horsepower required to compress the air may be found from the B.t.u. per hour," as indicated by a scale along the right-hand edge of the chart, and "the heat available for heating from the compressed-air transmission pipes can also be readily determined." These statements are seriously in error and are misleading in the extreme.

It is evident from the chart that this scale of B.t.u. measures some heat quantity that is proportional to the rise in temperature and independent of the value of the exponent in the compression equation, and it seems to be assumed that the net work done by the compressor is such a quantity. This assumption is not true, since the ratio of the net work done to the rise in temperature depends upon the value of the exponent, so that for a given rise in temperature we cannot say how much work has been done until we know the value of the exponent of the compression equation. It seems probable that Mr. Bennett has computed this net work done for the true adiabatic compression, since readings from his scale check computed results at several points. The scale therefore gives the B.t.u. of net work done by the compressor in drawing in a cylinderful of air, compressing it and discharging it against a constant pressure, for true adiabatic compression only. For compression corresponding to any value of the exponent other than 1.4037, this scale is meaningless.

Furthermore, as noted, even in the case of true adiabatic compression only a portion of the net work done is actually stored in the air as heat, hence this scale does not tell us how much heat is actually stored in the air "available for heating."

There is a quantity that might have been represented by such a vertical scale of B.t.u. It is the increase, due to the compression, of the intrinsic heat stored in the air. This quantity is strictly proportional to the temperature rise, at least for the range of pressures and temperatures appearing on this chart. It depends on nothing else but the temperature rise. It is computed by multiplying together the weight of air involved, the temperature rise and the constant-volume specific heat of the air. Since the values on the chart are computed by using the constant-pressure specific heat, they are about 40 per cent. higher than this change of intrinsic heat in the air.

I have examined the chart with care, computing values for about 40 points to test the accuracy of plotting and find several of the volume lines very inaccurately located and the curves for the various values of the exponent of the compression equation, with the exception of the adiabatic line, entirely wrong, in some cases giving temperatures in error as much as 20 deg. F.

It is unfortunate that this chart has been prepared in this manner, so full of errors, for charts are great labor-saving devices. However, in all cases one should refrain from the use of a chart until he is certain that the various quantities have been computed and plotted accurately and understands exactly what each item means. Furthermore, the construction of a chart of reasonable simplicity often demands that its field of application be limited by narrow boundaries, and the user of the chart should bear in mind constantly these limits and never try to apply the chart to a problem beyond them even slightly, as what appears to be a slight divergence may often produce the most surprising errors in results.

Ithaca, N. Y. C. H. Berry.

Steam Risers Larger at Top

Articles pertaining to resistance of flow through steam mains and heating systems and to the difficulty experienced with underground piping appear in mechanical papers at intervals. By study and experiment during the last 22 years, I have found that past and present methods are not in accord with the philosophy of the flow of steam, and I give the results obtained from installations made under my supervision and embodying my idea of reversing the customary design of a heating system. In a building 380x190 ft., 11 stories high, containing over 11,000,000 cu.ft. of space, built in 1892, all risers are upside down, or in other words, start with a 3-in. pipe from the main in the basement and are enlarged to 3½-in., 4-in. and are 4½-in. at the 11th floor, which allows a free flow of steam without resistance. This condition is proved by a steam gage on the main and one on the top of the riser, which indicate the same pressure—one pound, the usual pressure, or less, according to weather conditions.

This construction (with the risers enlarged in the upward direction) I find more economical and efficient for the reason that when the condensation drops into the riser and is broken up into small particles, it is absorbed by the higher temperature of the upflowing steam and is again converted into steam and used over again in the radiators; and from tests made we find this results in a saving of from 12 to 18 per cent., according to weather conditions. In 1914 another building was equipped in the same manner and with the same results.

A chimney was once built under my direction, embodying this principle, that was only 85 ft. high in place of 110 ft., as recommended by the architects. It was 20 per cent. smaller on the inside at the bottom than at the top. A test of the velocity of flow of the gases through it proved it to be equal to a stack 154 ft. high, figured at the average diameter of the 85-ft. stack. It is difficult to convince anyone that with the area increased toward the top, the gases are released much faster and without resistance, but in Switzerland and others parts of Europe stacks are being built on this principle.

Chicago, Ill. John G. Broman.

Centrifugal Boiler-Feed Pumps

Concerning the advantages and disadvantages of the centrifugal boiler-feed pump, I have obtained comparative data on the cost of operating a pump of this type driven by a steam turbine and a compound duplex pump of approximately 250 gal. per min. capacity, each supplied with steam at 160 lb. pressure and exhaust against 2 lb. back pressure. The following estimate is based on a nine-hour day, and the figures show the centrifugal turbine-driven unit to be greatly superior to the reciprocating pump in respect to economy and low cost of maintenance:

	Turbine-Driven Centrifugal	Compound Duplex
First cost	$1,008	$980
Number of valves to be watched	0	14 to 18
Number of packing boxes	4	18
Amount of oil used in 15 days	About 4 pt.	30 pt.
Amount of grease	4 lb.	0
Maintenance, packing, etc., per year	$30	$120
Steam consumption per b.hp.	38 to 40 lb.	40 to 55 lb.

The statement was obtained from one of the largest manufacturing plants in the country and is given to show what has been accomplished in a fairly large centrifugal boiler-feed pump.

Hartford, Conn. J. Breslav.

Inquiries of General Interest

Connecting Ammeter in Single-Phase Circuit—In a single-phase circuit, on which side should an ammeter be connected? C. E. F.

In a single-phase circuit the ammeter may be connected on either side.

Clamping Safety Valve for Hydrostatic-Pressure Test—In making a hydrostatic test of a boiler, how can a spring-loaded safety valve be kept closed without altering the setting of the valve? W. N. A.

The valve should be held to its seat by a testing clamp or gag such as usually furnished for the purpose by manufacturers of spring-loaded safety valves.

Protection of Blowoff Pipe—How can the blowoff pipe of a return-tubular boiler be prevented from burning out? J. N.

The blowoff should be opened frequently enough to keep the pipe clear, and a bottom blowoff pipe that would be exposed to direct furnace heat should be protected by firebrick, a substantial cast-iron removable sleeve or a covering of non-conducting material.

Melting Point of Fusible Plugs—What temperature is required to melt or burn out a fusible plug? A. S.

Fusible plugs are usually made of tin, the melting point of which varies between 440 and 450 deg. F. according to the purity of the metal. The rules of the United States Supervising Inspectors specify the employment of Banca tin. Its melting point is about 445 deg. F. The small end of the tapered tin plug that is placed toward the fire soon becomes coated with soot, and a temperature of fire somewhat higher than the melting point of the tin is required for fusion of the plug.

Wetting Down Slack Before Firing—What is the advantage of wetting down a mixture of anthracite and bituminous slack just prior to its use as fuel in boiler furnaces? G. R.

Although moistening the fuel detracts from its heat value, the loss is usually more than compensated by prevention of dust in handling and, especially where there is a strong or forced draft, wetting down will generally be of advantage to prevent fine fuel particles from being caught up by the draft and deposited on the heating surfaces of the boiler or swept out of the chimney in the form of unburned coal or ashes.

Stopping Inaccessible Leak of Boiler—Since using a boiler compound a leak has started in a girth seam of a locomotive boiler at a place where the barrel of the boiler is supported on a concrete pier. What would cause such a leak, and how could it be stopped without taking down the pier to obta'n access to the joint for calking? L. J. F.

The compound undoubtedly loosened or dissolved the scale at the joint, leaving the joint open. Such leaks, when not too large, will usually be stopped by placing in the boiler about a half-peck of bran or three to four pounds of corn-starch.

Section of Material of Safety-Valve Springs—Why are springs of safety valves made of square section instead of round material? F. A. K.

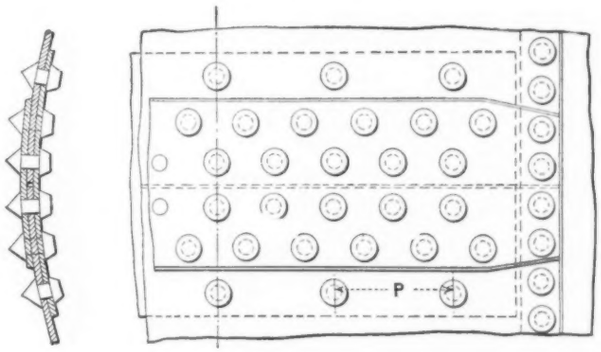
Material of square section offers greater resistance per coil for the same inside and outside diameter of spring and retains alignment of the spring better than round sections after the coils have been compressed together. Other advantages of square over round section are that the ends of the spring can be finished to afford better bearings than obtainable with round material, and in the production of springs of given strength the resistance of the springs can be reduced to the desired amount with greater uniformity in the strength of the coils by the process of grinding off a portion of the outside diameter of the springs.

Relative Economy of Heating by Exhaust Steam—Would it be more economical to supply a steam-heating system with live steam reduced from 90 lb. gage to 6 lb. or with exhaust steam in a case where the m.e.p. of the engine is 36 lb. with 2 lb. back pressure when exhausting to the atmosphere? E. A. D.

With the same load, the additional amount of steam required by the engine with the back pressure increased from 2 to 6 lb. would be practically the same as though the load were so increased as to require 4 lb. greater mean effective pressure, and under conditions of average practice the engine would have to be supplied with approximately $\frac{4}{36}$, or about 11 per cent., more steam. Therefore, if the heating system, when supplied through a reducing valve, requires more than about 11 per cent. as much steam as the engine uses when operated with 2 lb. back pressure, it would be more economical to do the heating with exhaust steam.

Efficiency of Butt and Double-Strap Joint Triple-Riveted—What is the efficiency of a butt and double-strap joint triple-riveted, where the tensile strength of the plates is 55,000 lb. per sq.in. of cross-section; thickness of main plates, $\frac{7}{16}$ in.; thickness of butt straps, $\frac{3}{8}$ in.; pitch of rivets, 6¾ in. on the rows having the greatest pitch; diameter of rivet after driving, $1\frac{1}{16}$ in.; assuming the shearing strength of rivet in single shear 44,000 lb. per sq.in., strength of rivet in double shear 88,000 lb. per sq.in. and crushing strength of the material 95,000 lb. per sq.in.? L. M. P.

As the thickness of main plates would be $\frac{7}{16}$ in. = 0.4375 in., the thickness of butt straps $\frac{3}{8}$ in. = 0.375 in., the pitch of rivets on the row having the greatest pitch = P in the figure = 6¾ in., or 6.75 in., and the diameter of rivets after



BUTT AND DOUBLE STRAP JOINT TRIPLE-RIVETED

driving = $1\frac{1}{16}$ in. or 0.9375 in. dia. = 0.6903 sq.in. cross-sectional area, then for one pitch length P of the joint,

A. The strength of solid plate = 6.75 × 0.4375 × 55,000 = 162,422 lb.

B. The strength of plate between rivet holes in the outer row = (6.75 — 0.9375) 0.4375 × 55,000 = 139,863 lb.

C. The shearing strength of 4 rivets in double shear plus the shearing strength of 1 rivet in single shear = (4 × 88,000 × 0.6903) + (1 × 44,000 × 0.6903) = 273,359 lb.

D. The strength of plate between rivet holes in the second row, plus the shearing strength of 1 rivet in single shear in the outer row = [6.75 — (2 × 0.9375)] 0.4375 × 55,000 + (1 × 0.6903 × 44,000) = 147,678 lb.

E. The strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of 1 rivet in the outer row = [6.75 — (2 × 0.9375)] 0.4375 × 55,000 + (0.9375 × 0.375 × 95,000) = 150,703 lb.

F. The crushing strength of plate in front of 4 rivets, plus the crushing strength of butt strap in front of 1 rivet = (4 × 0.9375 × 0.4375 × 95,000) + (1 × 0.9375 × 0.375 × 95,000) = 189,258 lb.

G. The crushing strength of plate in front of 4 rivets, plus the shearing strength on 1 rivet in single shear = (4 × 0.9375 × 0.4375 × 95,000) + (1 × 0.6903 × 44,000) = 186,233 lb.

As the strength of the joint would depend on consideration B, viz., 139,863 lb. per length P of the joint, the efficiency = $\frac{B}{A} = \frac{139,863}{162,422} = 86.1$ per cent.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

The Use of the Orsat*

By Henry Kreisinger† and F. K. Ovitz‡

SYNOPSIS—A description of the Orsat apparatus and its use in the analysis of boiler flue gases, written especially for the power-plant man.

The essential parts of the Orsat apparatus are a measuring burette, three absorption pipettes, a leveling bottle and a header, all of which are made of glass. These glass parts are inclosed in a compact wooden case. The measuring burette is a cylindrical glass vessel graduated into 100 units, each unit being graduated into fifths. The burette of the Orsat has a volume of 100 c.c., and the volume of the burette of the half-size apparatus is 50 c.c. A volume of 16.38 c.c. is equal to 1 cu.in. The burette is used for measuring the volume of gases during the process of analysis. It is inclosed in a water jacket which prevents sudden changes in temperature while the analysis is being made (see Figs. 1 and 2).

The absorption pipettes are U-shaped glass vessels and contain solutions for absorbing the three principal constituents of the flue gas. The one nearest the burette contains potassium-hydroxide solution for absorbing carbon dioxide, the second one contains an alkaline solution of pyrogallic acid for absorbing oxygen, and the third contains ammoniacal solution of cuprous chloride for absorbing carbon monoxide. The two kinds of absorption pipettes are shown in Fig. 3. The pipette with the opening and the ground-glass stopper near the top is not as good a design for general boiler-room work as the plain one. The stopper may become loose, and the gas or solutions may leak out and cause trouble. One arm of the pipette contains glass tubes to increase the surface of the liquid when in contact with the gas. To the other arm is attached a water seal or rubber bag to protect the solutions from deterioration by contact with air. The method

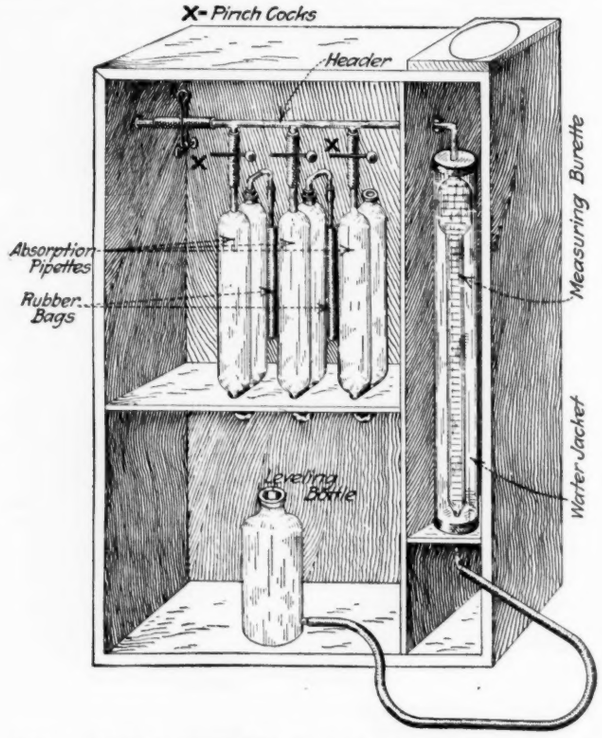


FIG. 1. ORSAT WITH PINCH COCKS AND RUBBER BAGS

of attaching the water seal or rubber bag is shown in Fig. 4. The water seal requires an extra pipette, three No. 0 rubber stoppers with one hole, a glass T and two right-angled glass bends. The joints should be made with ¼-in. black rubber tubing. The rubber bags are attached by means of a rubber stopper and short piece of black tubing. They should be air-tight, as otherwise they may cause much trouble. After two or three months the rubber becomes hard and the bags should be replaced by new ones. The water seal is most difficult to attach, but, once attached, is permanent and gives no trouble. Only the solutions for absorbing oxygen and carbon monoxide need to be protected.

The leveling bottle, which is connected to the burette with about 3 ft. of black rubber tubing, contains water. Lowering or raising the bottle causes water to act as a piston and draws

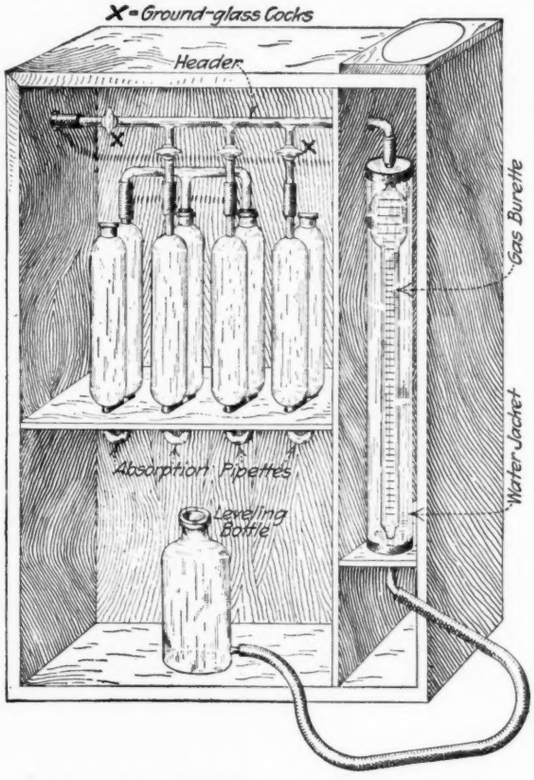


FIG. 2. ORSAT WITH GLASS STOPPERS AND WATER SEAL

gas into the measuring burette or forces gas out of it into any absorption pipette. The water in the leveling bottle is also used to regulate the pressure on the gas when its volume is being measured.

The header is glass tubing of small bore. The measuring burette and absorption pipette are attached to it with ¼-in. black rubber tubing. All the joints must be gas-tight. There is a glass stop-cock on the header between each pipette and the burette, and at one end of the header there is a three-way stop-cock, through which gas is taken into, or discharged from, the apparatus. The three-way cock has a spot of colored glass on it to indicate the direction of flow. Spring pinch-cocks may be used to replace the three stop-cocks between the pipettes and the burette, and thereby slightly reduce the cost of the apparatus.

The writers find the glass cocks more convenient to manipulate; but they require greater care to keep them in good working condition. They must be kept lubricated with vaseline, so that they will turn easily and will not stick. The vaseline should be applied in a thin film on the bearing surface of the cock and all excess avoided, for if too much is applied the small holes may become stopped.

The half-size Orsat being lighter than the full-size is preferable if the apparatus is to be carried from place to place. The Orsat may be purchased from any chemical-supply company. The cost of the full-size apparatus with glass stop-cocks is about $20, or with spring pinch-cocks, about $18. The half-size apparatus correspondingly equipped costs about $18 and $16. Usually the apparatus is fitted with rubber bags to protect the solution. If the water feed is wanted, it must be specified when purchased.

*From Bureau of Mines Bulletin No. 97.

†Engineer, Bureau of Mines.

‡Assistant chemist, Bureau of Mines.

In a gas analysis a manipulation of the Orsat consists mainly of two operations—moving the gases into the different parts of the apparatus and measuring their volume. The movement of the gases is done with the water in the burette and the leveling bottle. The water acts as a piston. When the leveling bottle is raised, the water flows by gravity into the burette and forces the gases into one of the absorption pipettes, or out of the apparatus, depending on which valve is open. If the leveling bottle is lowered, the water flows by gravity from the burette into the leveling bottle and the gas is drawn from the apparatus into the burette. This manipulation is indicated in Figs. 5 and 6. Fig. 5 shows the process of drawing the gas sample from the collecting bottle into the Orsat, the water flowing out of the burette into the leveling bottle. The three-way cock on the Orsat is opened in such a way that the gases flow from the collecting bottle to the measuring burette, the valves on all the absorption pipettes being closed.

When gas is being drawn from a pipette, care should be taken not to draw the solution into the valve or to run the solution into the water in the burette. The solution rises slowly as long as the level is in the wide part of the pipette, but as soon as it reaches the small bore it rises rapidly, and before an inexperienced operator realizes what is happening, part of the solution is drawn into the measuring burette. The best way to avoid such accidents is to operate the Orsat as shown in Fig. 7. The leveling bottle is manipulated with the right hand, while the rubber-tube connection is held between the thumb and the first finger on the left hand. If pressure is exerted on the rubber tubing, the flow of gas can be so reduced that it can be stopped easily with the top of the solution at any desired point in the neck of the pipette. When the solution has been brought to the point desired, the analyst may hold it there by pinching the rubber tubing, the leveling bottle being placed on the stand so as to leave the right hand free to manipulate the valve. The same manipulation should be used when the gas is being drawn from the absorption pipette.

The measurement of the volume is the most important operation. During any one analysis all movements of the gas volume must be made under constant temperature and pressure. A rise in temperature increases the volume of the gases. It is to avoid the change in the temperature that the measuring burette is water-jacketed. To further decrease the possibility of temperature changes, the apparatus should be in a place free from draft or heat radiation from the boiler or other part of the equipment. A change in pressure changes the volume of the gas, but as the atmospheric pressure changes little and slowly, the volume of gas is conveniently measured under atmospheric pressure. The gas from the measuring burette is brought under atmospheric pressure by holding the leveling bottle at such a position that the water

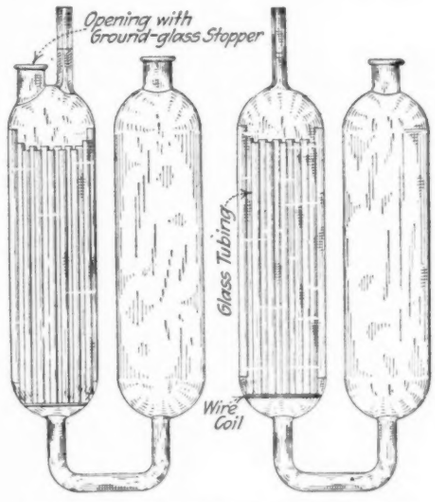
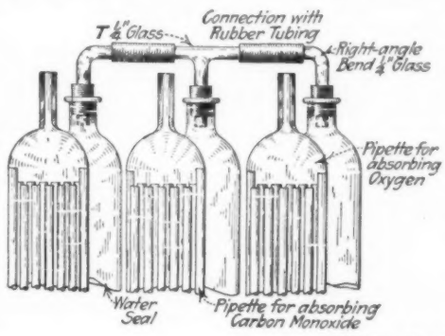


FIG. 3. TWO KINDS OF ABSORPTION PIPETTES

level in the burette and that in the leveling bottle are the same; that is, so that a horizontal line will pass through both levels. The position of the leveling bottle when the volume of the gas is read is shown in Fig. 8. When the reading is taken, the rubber tubing must be free from kinks.

The necessity of bringing the two levels to the same height before the volume is read can be appreciated by observing that raising or lowering the leveling bottle will give almost any desired volume in the burette. Another precaution that should be taken before the volume is read is to allow the water to drain down the sides of the burette for half a minute. The inside of the measuring burette should be kept clean that the water may drain well.

Careful attention should be given joints on the Orsat. In making connections the ends of the glass tubing should be brought close together and the rubber joints made tight. To test for leaks and for measuring, the burette is about half-filled with water and all the stop-cocks are closed. The leveling bottle is then lowered about two or three feet, the air inside the burette being placed under a reduced pressure. If the water in the burette falls to a certain point and then remains stationary, there is no leak. If it continues to fall slowly, there is a leak, which must be stopped before the analysis goes further. Before an analysis is begun, each solution must be brought to the mark on the stem of the pipette and the corresponding valve in the header closed. Any gas that has been drawn into the measuring burette is expelled and the water forced into the small-bore end of the burette. The apparatus is then ready for use.



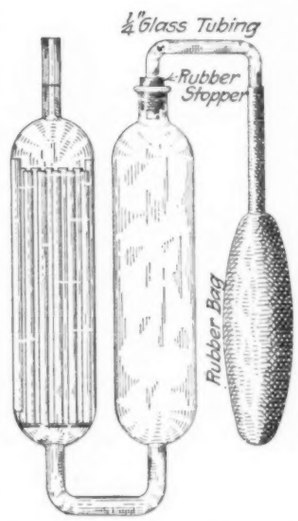


FIG. 4. HOW THE WATER SEAL AND RUBBER BAGS ARE ATTACHED

To take gas into the apparatus the end of the header is connected to the gas supply, such as a collecting bottle. The gas is drawn in by lowering the leveling bottle with the three-way cocks open to the gas supply, as shown in Fig. 5. It is forced out by raising the leveling bottle with the three-way cocks open to the outside air, as shown in Fig. 6. Before a sample for analysis is retained, three or four burettefuls of gas are drawn into and forced out of the apparatus. It is thus cleaned of all the residue from the previous analysis or of air, and a true sample of the flue gas can be obtained. After three or four burettefuls of gas have been rejected, one of gas is drawn into the apparatus and the three-way cock closed. The gas is placed under a slight pressure by raising the leveling bottle until the water is above the zero mark. The rubber tubing is then pressed between the thumb and first finger of the left hand and the leveling bottle placed below the lower end of the measuring burette. The pressure exerted with the left hand on the rubber tubing is slowly released and the water allowed to fall to the zero mark. It is held at this point by pinching the rubber tubing while the three-way cock is open to the outside air for a few seconds and closed. When the pressure on the tubing is released and the water in the leveling bottle is held at the same level as that in the burette, the level line should pass through a zero mark. If the line of common level does not pass through zero, the manipulation just described must be repeated.

When the volume of gas has been adjusted so that the water level passes through zero, the gas is forced into the pipette containing potassium-hydroxide solution. This is done as indicated in Fig. 7, the leveling bottle being raised above the Orsat so that the water flows into the burette. The rubber tubing is pressed between the thumb and first finger of the left hand, the leveling bottle placed on top of the Orsat and the valve leading to the first pipette opened. The pressure of the fingers on the rubber tube is released, allowing the water to run from the leveling bottle into the burette and forcing the gas into the pipette. When the water in the burette reaches the small-bore neck, the leveling bottle is lowered and the gas is drawn back into the burette, care

being taken not to draw the solution into the valve. The flow of gas can be nicely regulated with the pressure on the rubber tubing exerted by the thumb and forefinger. This operation is repeated three times, the gas being forced slowly into and drawn out of the pipette. After the gas has been drawn out of the pipette the last time, the solution is brought to the mark on the neck and the stop-cock closed. The volume is measured by bringing the water in the leveling bottle to the

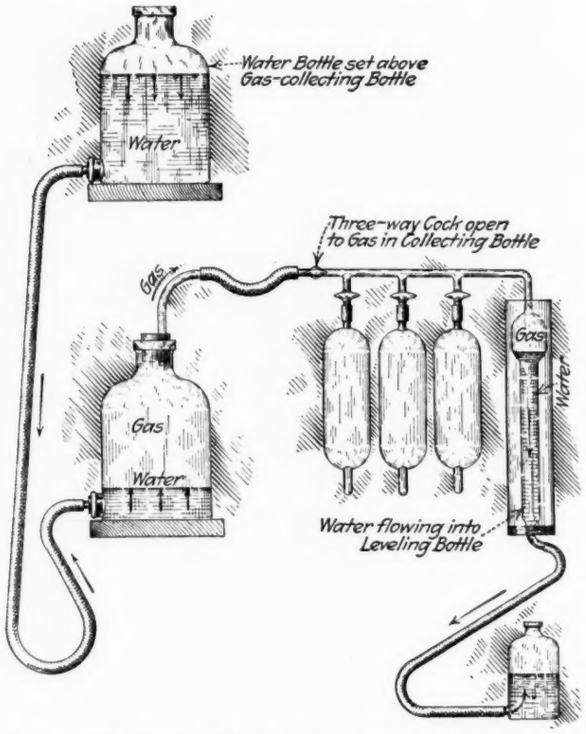


FIG. 5. POSITION OF LEVELING BOTTLE WHEN GAS IS DRAWN INTO BURETTE

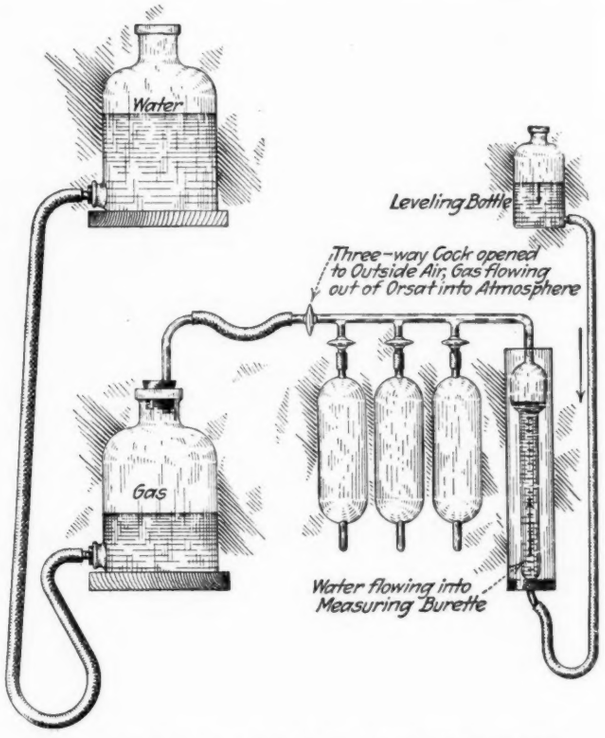

Water
Leveling Bottle
Three-way Cock opened to Outside Air, Gas flowing out of Orsat into Atmosphere
Gas
Water flowing into Measuring Burette

FIG. 6. POSITION OF LEVELING BOTTLE WHEN GAS IS EXPELLED TO THE AIR

level in the measuring burette, as shown in Fig. 8. The gas is then forced again into the pipette and drawn into the burette and the volume measured once more. If the two readings are the same, all of the carbon dioxide has been absorbed. If not, the operation is repeated until two readings are obtained which are the same, making certain that there is no more CO_2 to be absorbed.

The reduction in the volume of gas is due to the absorption of the carbon dioxide by the solution, and it is the measure of the amount of this constituent in the gas. It is well to remember that when the gas is drawn out of the pipette, the solution should always be brought to the same mark on the stem and the valve closed before the volume is measured. The solution can be brought to the mark to a nicety by throttling the water in the rubber tubing with the thumb and finger of the left hand. The transferring of the gas from the burette to the pipette and back can be done much easier if the left hand is held constantly on the tubing ready to throttle the flow of water whenever an exact adjustment of the level is required. The manipulation is that indicated in Fig. 7. Care should be taken not to run water into the header, particularly not to draw solution into the stop-cocks. If the glass tubes and the pipettes are not properly arranged, gas may pass through them into the other arm of the pipette and be lost. The tube should be washed when the gas is being passed into the pipette and all gas loss avoided.

After all the carbon dioxide has been taken out, the remaining gas is forced into the second pipette, containing an alkaline solution of pyrogallic acid, which absorbs the oxygen. The gas is moved back and forth as in the analysis for carbon dioxide. Oxygen is absorbed much more slowly than carbon dioxide, therefore the gas must be passed into and out of the pipette a greater number of times. The absorption should be continued until two successive measurements are the same. The contraction in volume is the amount of oxygen in the gas.

Carbon monoxide is absorbed in an ammoniacal solution of cuprous chloride. After the carbon dioxide and oxygen have been removed, the carbon monoxide in the remainder of the gas is absorbed in the third pipette in the same manner as in the preceding determination. Accurate determination of the carbon monoxide is difficult. Cuprous chloride solution, after being used for some time, will not remove all of the carbon monoxide. Moreover, if gas containing no carbon monoxide is passed into a solution that has absorbed carbon monoxide previously, some of it will

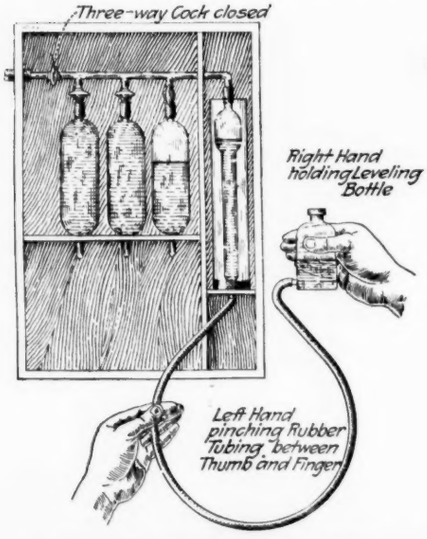


FIG. 7. DRAWING GAS FROM ABSORPTION PIPETTE

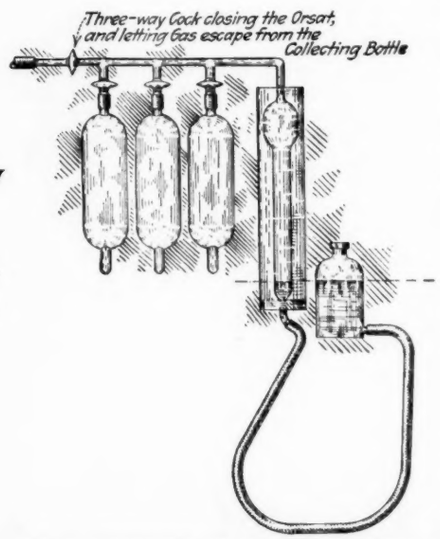


FIG. 8. POSITION OF LEVELING BOTTLE WHEN TAKING READING

be given off and an increased volume will result. To obtain accurate results the solution must be renewed frequently.

Analysis is started with a measuring burette filled with the gas to the zero point. The gas is forced into and drawn out of the first pipette three times. The volume measures, say, 5.2. The gas is forced into and drawn out of the pipette once more. The volume is the same as before, therefore, all carbon dioxide has been absorbed. The contraction, or the carbon dioxide absorbed, is 5.2. The remaining gas is forced into and drawn out of the second (oxygen) pipette five times. The volume is found to be, say, 19.4. The gas is forced through and drawn out of the pipette twice more and the volume found to be, say, 19.6, showing that all the oxygen had not previously been absorbed. If after two more passages the volume remains 19.6, all of the oxygen has been removed. The contraction is 19.6 — 5.2 = 14.4, which is the amount of oxygen in the gas. The remaining gas is forced into and drawn out of the third pipette three times. The volume is measured and no contraction observed, therefore no carbon monoxide is present.

The analysis is recorded in percentage by volume. As mentioned previously, the measuring burette is graduated in 100 units, the units being further graduated to fifths. If the sample fills the burette to the zero mark, the contraction can be read in terms of percentage by volume. If the sample of gas does not fill the burette to the zero mark, the contraction divided by the volume of gas taken for analysis and multiplied by 100 equals the percentage by volume. An example will illustrate: The volume of gas taken for analysis is 49 units. After carbon dioxide has been absorbed, the volume is 44.2 units. The contraction is 49 — 44.2 = 4.8 units; $\frac{4.8}{49} \times 100 =$ 9.8 per cent. of carbon dioxide. After the oxygen has been absorbed the volume is 39.8 units. The contraction is 44.2 — 39.8 = 4.4 units; $\frac{4.4}{49} \times 100 =$ 9 per cent. of oxygen. It is better, if possible, to fill the burette to the zero point.

Accurate results can be obtained only by close attention to detail. The apparatus must be gas-tight. A test for leaks should be made each day before an analysis is begun. The constituents must be absorbed in the proper order: First, carbon dioxide; second, oxygen; and third, carbon monoxide. The solutions for oxygen and carbon monoxide absorb carbon dioxide, and the solution for carbon monoxide absorbs oxygen also. Therefore each constituent must be removed completely before absorption in the next is begun. The solutions should be replaced by fresh ones when the absorption becomes slow. All measurements of volume must be made under the same pressure. Changes in temperature during an analysis should, of course, be avoided.

Never allow solution to get into the water in the leveling bottle, as the water will then absorb some of the gas and give a CO_2 reading that is too low. If the solution ever gets in contact with the three-way cocks, they should be washed immediately. The water in the leveling bottle should be renewed when it gets dirty; the burette and header must, of course, be kept clean.

Ohio Engineers Meet at Columbus

On Feb. 16, at the Chittenden Hotel, Columbus, the newly created station operating men's section of the Ohio Electric Light Association held its first conference under the direction of the station operating committee. The gathering was strictly informal and the speaking impromptu. There were no prepared papers. Each man present was urged to discuss the various questions on operation brought up for consideration. The object of these meetings, of which there probably will be three per year in addition to the annual convention, is to get engineers together for an exchange of ideas on similar troubles and experiences in the power plant. Between meetings the committee will act as a clearing house, assembling and arranging items mailed in by the members for publication in the monthly bulletin issued by the association.

W. A. Wolls, business manager of the Columbus Railway, Power and Light Co., welcomed the engineers to the city. He was glad to see them assembled to discuss operating problems, for in this end of the electric business more and more concentrated effort was being required. The success of the company depended largely on the skill of operation. Such meetings as the present were sure to result in a world of good.

As a suggestion for topics to be discussed or for papers to be prepared later, William Long, of the Toledo Railways and Light Co., gave preliminary sketches of the many problems that might be of interest to station operators. The list was long enough to include the entire circle of power-plant operation. Following is a summary: The location and design of the power plant, type and size of apparatus installed, the proper selection of coal, lubrication of turbines and engines, organization and coöperation of the power-plant force, 25-vs. 60-cycle current, the station's log, boiler-room economics requiring special attention to the handling and passing, sampling and testing and storage and washing of coal, and the handling of ashes. A brief outline of each topic suggested the various angles from which these subjects might be considered.

SECURING A PROPER HEAT BALANCE

In the opinion of C. A. Spiehler, of the Dayton Power and Light Co., insufficient attention had been paid to the selection of auxiliaries for the purpose of securing a proper heat balance. In one of their plants from 8 to 10 lb. of the steam required to generate a kilowatt-hour was thrown overboard. In one of their new units, however, in connection with which they had installed a steam-driven air pump and a motor-driven condensate pump, a happy balance had been obtained. No exhaust steam was wasted, and the over-all economy of the unit was maintained at the maximum.

Norman G. Reinicker stated that the auxiliaries took the same quantity of steam over all loads on the main unit, so that at light loads there would be an excess of exhaust steam. It was important to determine over what range of load the auxiliaries might operate with economy. At Delray the Detroit Edison Co. took care of the heat balance by installing a certain number of pumps—part steam- and part electric-driven. With this provision one type or other of pump could be used, in accordance with the need for exhaust steam. In smaller stations this same idea might be carried out and extended to the boiler-feed and emergency pumps.

Mr. Long's solution of the heat-balance problem was duplicate units for emergency use, one set being steam-driven and the other electric-driven. The initial cost would be small in proportion to the saving effected.

Where duplicate units cannot be installed, it was suggested that the auxiliaries should be planned so that the exhaust steam would be under rather than over the average requirements. If the feed water has to be heated to a certain temperature for chemical treatment, live steam might be used to supplement the exhaust. The question of turning the surplus exhaust steam from the auxiliaries into the lower stages of the main turbine was also discussed and approved. Mention was made of the special arrangement at Conners Creek by which practically all auxiliaries were motor-driven and the feed water was heated in a jet condenser by the exhaust from a special house alternator that supplied current to the auxiliaries. It was pointed out that the maximum advantage with this scheme was reached in connection with economizers. In smaller stations already installed, which had a surplus of exhaust steam from the auxiliaries, it was decided better practice to turn this exhaust into the condenser of the main unit and save the hot water rather than allow it to escape to the atmosphere.

R. J. Feather, of the Columbus Railway, Power and Light Co., favored a double source of power for the auxiliaries—that is, a low-speed turbine on one end of the pump shaft and an induction motor on the other. It would then be possible to use just as much steam on the auxiliaries as was required by alternating between the turbine and the motor. The latter should be connected to the machine side of the generator switch or circuit-breaker, with a throwover switch for starting from the bus. As to the reliability of the motor-driven circulating pump it was the consensus of opinion that the pump should have a double drive—that is, both turbine and motor. Otherwise a "kick-off" on the line might easily interrupt the operation of the motor and perhaps cause a shutdown of the main unit. With the two sources of power a shutdown was less likely and if it did occur it would be of shorter duration.

PROPER SIZE AND NUMBER OF BOILERS

E. P. Roberts, of Cleveland, introduced the subject of sizes of boilers by stating that too many plants were not properly proportioned for the load they had to carry. The stokers were not suited to the boilers, and the auxiliaries and the piping,

while suitable for full-load conditions, were not right for average loads or emergencies.

While the size of the boiler depends somewhat on the method of firing or the type of stoker, it should bear a certain relation to the size of the plant. The same ruling applies to the capacity of the turbines. Large plants are generally built on the unit system, and the size and number of boilers are directly related to the size of the turbine and the excess capacity needed in the event of a breakdown of one element of the unit.

The use of relatively large boilers was favored, as a small number of units with large overload capacity, rather than a large number of smaller boilers, saved on the initial investment. The term large was only relative. A boiler should not be rated in horsepower. It was a question of the amount of heat absorbed by the surface in the boiler and the pounds of coal that could be burned per square foot of grate.

Large boilers with high overload capacity could be used in small stations. With the proper furnace the economy at 300 per cent. of rating was often nearly as good as when the boiler was operated at normal rating. Consequently the drop in efficiency would be negligible and the initial investment would be less, as would also the upkeep and the labor required to operate. The word "overload" was perhaps unfortunate, as the present standard of rating had no significance. As soon as boilers were given a wide range of capacity, the question of large units would be settled.

It was pointed out that the boiler itself was one of the most reliable pieces of equipment in the plant. Shutdowns were usually due to the furnace or the stoker, these being the vital elements of the installation. As to higher maintenance costs when the boilers are operated continuously at overload, it depended a great deal on whether the furnace and stokers were designed to meet the conditions. If the old types of furnace were retained, the upkeep would probably be higher. Mr. Spiehler referred to a plant containing three 1,155-hp. boilers with suitable furnaces and stokers and four 500-hp. boilers equipped with the old type of furnace. Fully 90 per cent. of the total maintenance in the boiler room was due to the smaller boilers.

ORGANIZATION AND CO-OPERATION

At the close of the noon luncheon M. S. Hopkins, vice-president of the E. W. Clark Management Corporation, gave an interesting address on coöperation, citing in particular the Pennsylvania Railway organization. He is a great believer in instruments in the power plant. He believes in knowing what the boilers and generating units are doing, and that it is important to separate the results from these two departments. Plenty of recording instruments should be installed, and the records should be open to the entire force. It is his policy to encourage and educate the men and ultimately develop a management and organization which will work together for a common end and give very definite results.

The remarks of the first speaker were seconded by Mr. McMeen of the Columbus Railway, Power and Light Co. A good organization and coöperation are absolutely necessary to secure results. It should be the desire of every efficient management to get in close contact with the man on the firing line and get suggestions for improvement from the men doing the work. Only in this way can the company reach the highest point of efficiency.

EFFICIENT BOILER-ROOM OPERATION

At the afternoon session Norman G. Reinicker of the New York Edison Co., talked briefly on boiler-room operation. In his opinion good apparatus alone will not secure the best results in a boiler room. If the apparatus is not installed so that it can be operated easily and quickly, giving the operator an opportunity to watch results, the highest economy cannot be obtained. Labor-saving devices and foresight in laying out the plant are essential to high efficiency.

A clean well-lighted plant has its influence on the men and results in lower production costs. Maintained interest in the work by the operating men is also essential. It is important to have the men think that they are part of, and essential to, the company. Suggestions from the men should be encouraged and their opinions given weight, all of which tends to form an organization working for company interests and resulting in greater care being taken of apparatus and closer watching of the fires.

The chief duty of the fireman is to generate steam at varying demands. To better prepare the number and condition of the fires to handle these changes, the fireman should be given every opportunity of knowing when they will occur. Large-faced steam gages that can be read at a distance help. These instruments have a range of 30 lb., and changes of ½ lb. are indicated and can be seen 200 ft. away. Any change in pressure will show up almost immediately and give the operator a chance to get his fires in condition. A recording steam-pressure gage prominently located in the boiler room will enable the operators to see a record of their own work as it is being done, and simultaneously their work takes new interest. A clock in a boiler room is almost as essential as a steam gage. Changes in load follow some degree of regularity and knowing the time of these respective changes enables the fireman to prepare accordingly. To secure the highest results the equipment must be made to pass from one load to the other with a minimum disturbance of the fires.

The term automatic as applied to stokers is unfortunate. No mechanical stoker can adjust itself to wetness, dryness, quality or rate of burning of coal. These factors must be under the control of the operator. As the same combination of these four variables seldom exists for any considerable length of time, the problem is an ever-changing one.

Too many tests are made to determine the most efficient point at which to operate boilers and stokers, neglecting to determine the economical range of operation. Owing to the character of the load boilers must run at various rates, and it is just as important to know the best methods of carrying fires at these various periods—night and peak loads for instance—as it is during the ordinary day loads.

Operating a boiler room with only a steam gage is like operating a switchboard with only a voltmeter. Draft gages, when properly installed and kept in adjustment, will soon pay for themselves if their indications are intelligently interpreted and the means of controlling draft are centralized. Too many plants have draft gages put in a convenient place near the front of the boiler setting, while the damper control may be almost any place except near the instrument. Consequently it is impossible to see the immediate result of a change in the damper and small adjustments are usually neglected and the gain due to them lost.

The speaker dwelt upon the advantages of flue-gas analyses and the importance of explaining the results to the operator and helping him to secure better results or to hold those obtained. Too often gas analyses are limited to the day shift, the importance of watching combustion at night being entirely overlooked. Often more coal is wasted at night by indifferent firing than the instruments and analyses save during the day.

It is important that the gas analyses show the operator what he is doing at the time. Continuous records shown the next day have no effect, as he cannot remember the conditions accurately. If in the immediate readings he sees any reason for improving the fire, he does it, and another analysis shows the results.

As the boiler room offers the greatest opportunity for saving, it is economy to get the best men obtainable, pay them good wages, give them every advantage, encourage them to make suggestions and occasionally, when the daily routine gets monotonous, give them a change of scenery. Send them to other plants—not sight-seeing, but on visits of several days, so that they may see how other plants are operated and not get in a rut in their own station. This applies particularly to the chief, as trips for the entire force might be too expensive. The men should be given days off, with pay, as often as they can be spared.

Summarized, a well-lighted clean place to work, best available man in charge, apparatus and instruments to show results, continual instructions and well-paid men are essential to continued highest efficiency.

SEPARATE THE BOILER AND FURNACE

In a short talk E. P. Roberts, of Cleveland, emphasized the importance of separating the boiler and furnace. A good boiler and a good stoker may be hitched together without good results unless they are adapted to each other. The function of the furnace is to burn coal, and the function of the boiler is to absorb heat. To determine the number and size of boilers typical load curves on typical days should be made, and load curves for the furnaces under the same conditions before the square feet of grate surface they are to contain is settled. Then it is necessary to hitch the boiler and furnace together, to determine the character of coal that is to be used and the height and diameter of stack that will give the proper draft over the fire. Attention must be given to the probable drop of draft that may occur between the stack and the furnace. Mr. Roberts exhibited a Ringelmann chart which he had gotten up in circular form, demonstrated a smoke indicator and spoke of the advantages to be obtained from flue-gas analyses. He favored the abundant use of instruments such as draft gages, recording steam gages, flow meters, etc., all of which have value only if their readings are properly analyzed and interpreted. In his opinion the boiler-room force, to get the best results, should have a boiler-room switchboard, with all instruments necessary to show the men exactly what they are doing.

In the discussion Prof. Henry B. Dates, from the Case School of Applied Science in Cleveland, spoke of the diversity of spirit displayed in different plants and gave his version of the causes. He emphasized the importance of instruments in the boiler room to guide the firemen instead of expecting them to do the work by routine. Switchboard operators were provided with all the instruments necessary and carefully instructed in their use. It was even more important to instruct the firemen in the use and interpretation of boiler-room instruments. In the efficient operation of the plant the personal element was the big thing and better surroundings an important factor influencing the cost of production.

Hours of service and the advantage of banking versus letting the fires die down at night were other questions briefly discussed.

Tests of Champion Rivets

A pamphlet has been received from the Champion Rivet Co., Cleveland, Ohio, devoted to tests to determine the shearing strength of this company's boiler rivets and "Navy high tensile" steel rivets for steel hulls. The boiler rivets were tested by R. H. Danforth, of the Case School of Applied Science, Cleveland, Ohio, and the hull rivets by W. B. Petch, inspector of hull material, United States Navy. The following is from Mr. Danforth's report:

Six sections of boiler-plate joints were tested. The plate was supplied and the riveting done by the D. Connelly Boiler Co., of Cleveland, which also furnished the rivets, certifying that they were from regular stock of soft-steel rivets made by the Champion Rivet Co., which meet the requirements of the American Society for Testing Materials. Riveting was done in the usual way, on a hydraulic riveter having a nominal closing pressure on the rivets of 75 tons.

The seams included two butt-joints with double cover-plates, single-riveted, and four lap-joints, double-riveted, as shown. The plate was of various thicknesses for different joints, as shown in the table. The rivets were all ¾ in. diameter, driven in $\frac{13}{16}$-in. holes. The joints were so proportioned that they would fail by shearing of the rivets, it being desired to check the assumed strength of the rivets in shear.

The specimens were pulled in a vertical universal Olsen testing machine of 200,000 lb. capacity, which is sensitive to about 50 lb. at a total load of 100,000 lb., so that the results may be considered correct within about $\frac{1}{10}$ of 1 per cent. The pull was applied to the specimens through pins 3 in. diameter passed through the main plates on each side of the joint, as shown, in such a way as to allow the joint sections to adjust themselves so that all rivets would take their share of the pull if all were equally well driven.

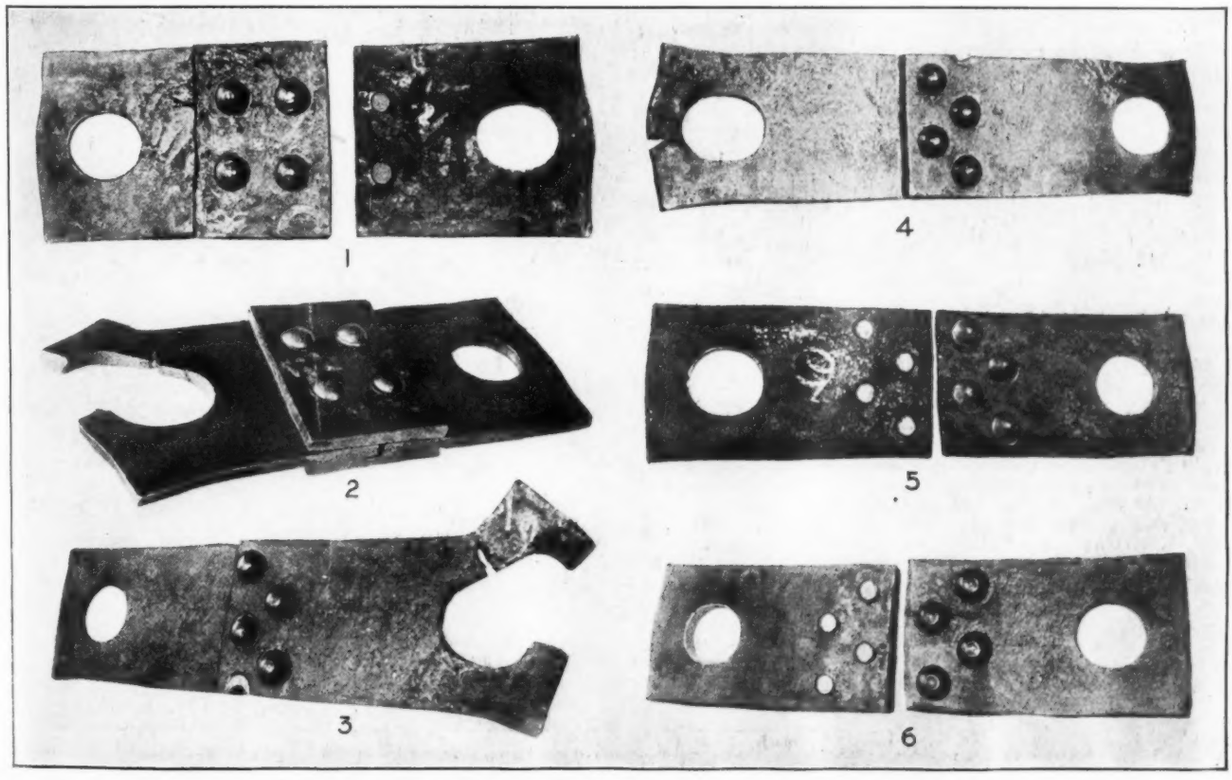
The two butt-joints failed with loads of 88,540 lb. and 94,630 lb. respectively, giving an average strength of the rivet material, figured from the driven area of the rivets, of 44,135 lb., single shear, or 88,270 lb. in double shear.

Two of the lap-joints failed by tearing the plate through the holes for the 3-in. equalizing pins, without developing the strength of the joints. The other two lap-joint specimens, made of thicker plate, sheared their rivets at loads of 97,900 lb. and 104,800 lb. respectively, giving an average strength in single shear, based upon the driven area, of 48,843 lb.

The accompanying table gives the details of each test.

TABULATION OF THE SIX TESTS

Joint No.	Description	Number of Rivets	Area in Shear, Sq.In.	Maximum Load, Lb.	Stress per Sq.In. Single Shear	Stress per Sq.In. Do'ble Shear	Remarks
1	Butt-joint with double cover plates, single-riveted.	2 rivets in double shear.	2.075	88,540	42,670	85,340	Main plates 9-16 in., cover plates ½-in. Failed by shear of two rivets.
2	Butt-joint with double cover plates, single-riveted.	2 rivets in double shear.	2.075	94,630	45,600	91,200	Main plate 9-16 in., cover plates ½-in. Failed by shear of one rivet.
3	Lap-joint, double-riveted, rivets staggered.	4 rivets in single shear.	2.075	65,420	.....	....	Plates 7-16 in. Failed by tearing plate outside of joint.
4	Lap-joint, double-riveted, rivets, staggered.	4 rivets in single shear.	2.075	67,540	.....	.....	Plates 7-16 in. Failed by tearing plate outside of joint.
5	Lap-joint, double-riveted, rivets staggered.	4 rivets in single shear.	2.075	97,900	47,180	.....	Plates ½-in. Failed by shear of all four rivets.
6	Lap-joint, double-riveted, rivets staggered.	4 rivets in single shear.	2.075	104,800	50,506	.....	Plates ½-in. Failed by shear of all four rivets.



JOINTS USED IN SHEARING STRENGTH TESTS OF CHAMPION RIVETS

Boiler Explosions During First Half of 1915

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
Jan. 1	Brooklyn, N. Y.	Brooklyn Edison Co.	11:50 p.m.	Water-tube	140	150 hp.	0	0	$600	Low water—cast-iron headers failed
Jan. 1	Salem, Mass.	Peabody Academy of Science		Cast-iron heating			0	0		Two sections ruptured
Jan. 2	Wheeling, W. Va.	Wheeling Traction Power House	5:30 p.m.	Horizontal-tubular		550 hp.	0	0		Tube blew out
Jan. 3	St. Louis, Mo.	Trorlicht-Duncker Carpet Co.	9:30 p.m.	Water-tube	120	250 hp.	1	2	$5	Bushing blew out. Down-draft furnace
Jan. 3	St. Louis, Mo.	Central Realty and Warehouse Co.					1	2		Furnace connection failed
Jan. 4	Kutztown, Penn.	H. W. Sharadin's					1	2		
Jan. 4	Tifton, Ga.	J. W. Hall's Shingle Mill					1	2		Mill wrecked
Jan. 5	Cleveland, Ohio	Jas. McNeil & Bros. Co.		Portable locomotive			0	0		Crown-sheet collapsed
Jan. 6	Marion, Ohio	Marion Water Company	5:30 p.m.	Return-tubular	90	72″ x 18′	0	0		Patch on fire-sheet failed
Jan. 8	Brackenridge, Penn.	Allegheny Steel Co.		Water-tube			0	0		Tube ruptured
Jan. 9	Chicago, Ill.	Heissler & Junge Co. Bakery	8:30 a.m.	Tubular	90	72″ x 18′	0	0	$150	Blowoff pipe ruptured
Jan. 10	Holyoke, Mass.	Apart. House—E. Hugo Freidrich		Cast-iron heating			0	0		Two sections ruptured
Jan. 11	Salem, Mass.	P. & R. Coal and Iron Co. Coal Pocket		Water-tube	120	150 hp.	0	0		Shell ruptured
Jan. 12	Ishpeming, Mich.	Pluto Powder Co.		Horizontal-tubular	110	150 hp.	0	0		Sulphate sediment
Jan. 13	Vicksburg, Miss.	Estate of J. Darnbush		Cotton-gin			0	0		Blowoff failed
Jan. 14	Hartford, Conn.	Pond Estate, 341-351 Trumbull St.		Cast-iron heating			0	0		
Jan. 14	Terre Haute, Ind.	S. J. Goldstine's Bakery		Hot-water heater			0	0		
Jan. 16	Richton, Miss.	Richton Lumber Co.	5:30 a.m.	Locomotive	145	19-ton loco.	0	0	$500	Crown-sheet ruptured
Jan. 19	Hillsdale, Mich.	Mosher House (Hotel)		Heating			0	0		Unknown
Jan. 20	One-half mile west Beverly, Mo.	Jos. Trusty's Portable Saw Mill	10:00 a.m.	Locomotive type			2	1		Crown-sheet failed
Jan. 21	La Paz, Mexico	U. S. Cruiser "San Diego"		Water-tube	200	500 hp.	9	0		Low water. Pump suction obstructed*
Jan. 22	Trenton, N. J.	People's Brewing Co.	9:00 a.m.	Water-tube	120	250 hp.	0	0		Cast-iron header failed
Jan. 23	Pittsburgh, Penn.	Hardie Bros. Co. Candy Factory		Return-tubular	100	60″ x 16′	0	0		Elbow on blowoff pipe failed
Jan. 25	Marshwood, Penn.	Moosic Coal Co.	7:30 p.m.	Locomotive			0	3		Crown-sheet failed
Jan. 27	Toledo, Ohio	F. Bissell Co.	7:00 a.m.	Cast-iron heating	10	5-36-7	0	0		Four sections ruptured
Jan. 27	Central City, Ky.	J. McElvain's Home		Kitchen boiler		30 gal.	0	0	$75	
Jan. 29	Ada, Okla.	Willard School		Cast-iron sectional heater			0	0		One section ruptured
Jan. 29	Lonsdale, R. I.	Lonsdale Co.		Water-tube			0	0		Tube ruptured
Jan. 30	Indiana, Penn.	East End School	Night	Cast-iron heating	15	48 gal.	0	0	$100	One section cracked
Jan. 31	Altoona, Penn.	Altoona Machine Shops					0	2		Ignition of soot
Jan. 31	Maywood, Ill.	Public Service Co. of No. Ill.	6:20 p.m.	Water-tube	150	350 hp.	0	1		Tube ruptured
Feb. 1	Racine, Wis.	Milwaukee Electric Ry. & Lt. Co.					0	1		
Feb. 1	Racine, Wis.	Klinkert Brewing Co.					0	1		
Feb. 1	Escanaba, Mich.	Northwestern Tie Preserving Co.	4:20 a.m.	Horizontal-brick set	110	100 hp.	0	0	$5,000	Unknown
Feb. 4	Kissimmee, Fla.	Bell Sawmill	7:30 a.m.				2	2		
Feb. 7	Madison, Wis.	Scanlan-Morris Co.	2:00 p.m.	Upright-tubular	65	10 hp.	0	1	$25,000	Too high pressure
Feb. 12	Near Reese, Texas	Sawmill of R. J. Liles	7:30 a.m.	Horizontal return-tubular		42 x 12	1	2	$475	Flaw
Feb. 14	Menlo, Iowa	Menlo Electric Light Plant	6:00 p.m.	Return-tubular	95	60 hp.	3	0		Shell failed
Feb. 22	Brockton, Mass.	Hotel Victoria		Cast-iron	70	3 ft. dia.	0	0	$500	Water-supply pipe plugged up
Feb. 23	Scranton, Penn.	Charles Schlager Home		Kitchen-range water-front	60		0	1	$50	Water-front piping choked
Mar. 3	Near New Orleans, La.	Country Club building		Heating			0	4		In testing, pressure quickly raised too high
Mar. 3	Brookline, Mass.	Apartment house, 52 Vernon St.	3:00 p.m.	Copper-water	85	60″ x 22″	0	0	$3,500	Defective tank. Relief valve set at 125 lb.
Mar. 3	Cedar Rapids, Iowa	Starch Works	9:00 p.m.	Water-tube	160	250 hp.	0	3		Flue exploded
Mar. 4	Near Bessemer, Ala.	Woodward Iron Co. Ore Mines No. 1					1	1		Cold water admitted into dry boiler
Mar. 5	New York City	Restaurant 373 West St.	7:00 a.m.	Heating			0	3		
Mar. 8	Souderton, Penn.	Quarry of Progressive Realty Co.	3:00 p.m.	Vertical-tubular	80	20 hp.	0	3	$1,500	Valve between boiler and safety pop closed
Mar. 12	San Francisco, Calif.	Steamer "Frederick Luckenbach"					0	1		
Mar. 13	Selmer, Tenn.	Glidwell's Sawmill					0	3		
Mar. 13	Tiffin, Ohio	Ohio Light and Power Co.	5:45 p.m.	Water-tube	140	350 hp.	0	2	$150	Header overheated by broken furnace crown
Mar. 17	West River, N. B., Canada	C. T. White & Son's Mill	6:00 p.m.	Return-tubular	80	16′ x 66″	2	4	$8,000	Water-hammer in long steam pipe
Mar. 17	New Haven, Conn.	198 Washington Ave.					0	0	Slight	
Mar. 18	Sterrett, Tex.	"Katy" Freight Engine	12 M.	Locomotive	150		0	2		Injector pipe burst
Mar. 20	Mahanoy City, Penn.	Lawrence Mine, Mahanoy Plane					0	0		
Mar. 27	Rocky River, Ohio	William Meese Property	8:00 a.m.	Duplex	110	30 hp.	1	2	$50	Excessive pressure
Mar. 27	Carroll Co., Va. (Mount Airy)	Sawmill	11:00 a.m.				2	2		Old boiler, high pressure
Mar. 29	Live Oak, Fla.	Live Oak Steam Laundry	1:00 p.m.	Horizontal	80	30 hp.	0	2	$300	Excess pressure
Mar. 31	Indianapolis, Ind.	Claypool Hotel	Evening	Water-tube	150	450 hp.	1	0		Tube failure
Apr. 5	Jefferson City, Mo.	State Penitentiary					0	1		
Apr. 9	Wahalak, Miss.	Sawmill of Capt. Guy Jack	9:00 a.m.	Horizontal-tubular	120	40 hp.	1	1	$1,000	Low water
Apr. 16	Washington, D. C.	German-American Building Ass'n.	12:00 a.m.	Auxiliary-heating			0	1	$500	Outlet valve closed
Apr. 17	Huntsville, Ont., Can.	Field Bros. Sawmill	8:10 a.m.	Horizontal-tubular	80	48″ x 12′	2	0		Overpressure. Obstruction in gage pipe
Apr. 18	Union City, Ind.	Long Produce Co.	2:00 a.m.	Horizontal-tubular	120	60″ x 16′	0	1	$100	Bursting of blowoff pipe
Apr. 21	Durham, N. C.	Durham Mill					0	2		
May 1	Harvard, Neb.	Harvard Electric Co.	10:00 a.m.	Horizontal return-tubular	120	72″ x 18′	0	0	$50	Elbow in blowoff pipe weakened
May 5	North Platte, Neb.	Doolittle Bakery		Hot-water-heater			0	1	$100	Overheated tank
May 5	Silvis, Iowa						0	1		Ignition of vaporized oil used to wash out boiler
May 11	Dundalk, Ont., Can.	D. C. McKenzie Tannery					0	0		
May 11	Charlotte, N. Y.	Gennesee Furnace and Coke Co.	3:15 a.m.	Water-tube	150	500 hp.	0	0	$25	Corrosion
May 12	Elgin, Ill.	Moosheart Farm					0	1		
May 13	Los Angeles, Calif.	Buckingham Apartment					1	1		
May 14	Zanesville, Ohio	Baltimore & Ohio R.R.					0	8		
May 14	Charles, Mich.	Loud Lumber Co.	2:00 p.m.	Cylindrical fire-tube	140	14′ x 66″	0	0	$100	Putting feed water into blowoff pipe
May 17	Worcester, Mass.	R. C. Taylor Estate		Cast-iron heating			0	0		Rupture of two sections
May 18	Atlantic Highlands N. J.	Pump Station, Central R.R. of N. J.					0	0		

* See "Power," Mar. 30, 1915.

BOILER EXPLOSIONS DURING FIRST HALF OF 1915—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
May 18	Baracoa, Cuba (30 miles out)	S. S. "Neptune"					1	0		
May 19	Laneseboro, Iowa	Cement Tile Co.					0	0	$1,500	
May 19	Cranbury Lake, N. B., Can.	Doten's Sawmill	9 : 00 a.m.	Multi-tubular	100	52" x 13'	1	4	$4,000	
May 23	Lindenhurst, N. Y.	Carrousel in Park					0	0		
May 24	Bordentown, N. J.	Delaware River Sand Dredging Co.	8 : 45 a.m.	Return-tubular	80	18' x 6'	5	2	$12,000	Unknown
May 24	Burlington, N. C.	Piedmont Railway and Electric Co.	4 : 00 p.m.	Water-tube	225	540 hp.	0	0	$800	Improperly rolled tubes blew out
May 24	Vincennes, Ind.	Applegate Lease					1	0		
May 28	Chester, W. Va.	American Sheet and Tin Plate Co.	10 : 30 a.m.	Water-tube	135	200 hp.	0	1		Defective flue burned off at bridge-wall
May 29	Watervliet, N. Y.	Jas. T. Young's Wood Working Plant	11 : 30 a.m.	Horizontal-tubular	80	44" x 12'	0	0	Boiler only	Crack at horizontal seam
May 29	Toledo, Ohio	Ohio Building	6 : 00 p.m.	Water-tube	120	300 hp.	1	0	$50	Defective boiler tube split in weld
May 30	Newtown, Penn.	Mahlon Fretz Home		Water-heating			0	0		
June 2	Fairview, Penn.	Rossone Farm					0	2		
June 5	Thomaston, Ga.	Thomaston Cotton Mills		Water-tube	65	44"	0	1		Tube ruptured
June 10	Pleasant Valley, Conn.	Rogers Rake Co.	9 : 15 a.m.	Horizontal	90	52"	0	2	$1,695	Shell weak below lap joint on under side
June 12	Meskill, Wash.	Meskill Lumber Co.	8 : 40 a.m.		172	480 hp.	1	0	$300	Low water
June 13	Detroit, Mich.	Detroit City Gas Co.	2 : 00 a.m.	Water-tube			0	0	$1,000	Obstructed tubes overheated, pulled out
June 13	Chesapeake Bay, Va.	U. S. S. "Bailey"		Water-tube			0	3		Tube rupture
June 13	Wilmington, Del.	1401 N. Jackson St.	1 : 00 p.m.	Hot-water-heating			0	0	$100	Overpressure. Boiler in poor shape
June 14	Edgewater, N. J.	Warner Sugar Refining Co.	7 : 30 a.m.	Water-tube	125	750 hp.	0	0	$100	Cast headers burst
June 17	Glens Falls, N. Y.	Y. M. C. A. Building	Early Morning	Sectional-heating	4		0	0	$105	Crack in manifold caused by expansion
June 17	Elliott Bay, Seattle, Wash.	Dredge "Olympia"		Water-tube			2	0		Split tube
June 21	Hazleton, Penn.	Kehoe & Co.		Locomotive			0	0		Crown-sheet pulled from bolts
June 22	Poughkeepsie, N. Y.	National Straw Hat Works					0	1		
June 22	Ogdensburg, N. Y.	Steam Roller					0	1		
June 24	Southampton, N. Y.	Suffolk Light, Heat and Power Co.		Water-tube			1	0		
June 24	Germania, Penn.	Frank Cizek & Son	6 : 55 a.m.	Tubular	120	12 hp.	0	0	$50	Weakened by rust
June 25	Williamsport, Penn.	Joseph Erick's Sawmill					1	0		

Total number of explosions 101. Fatalities 46 and injuries 89. Property loss reported in 36 cases $69,530. In all 19 domestic heaters, 13 tubes and 5 blowoff pipes failed.

Water-Power Legislation and the Senate

Although sidetracked occasionally for discussions of preparedness, the right of noncombatants to travel on armed merchantmen and other topics of immediate importance, water power has come in for considerable attention in the Senate during the past few weeks. There are several bills pending that relate to this important subject—some dealing with water-power development on the public lands of the United States and others on navigable streams.

The Ferris bill, which was before the previous Congress and which passed the House this session, was referred to the committee on Public Lands. In an attempt to kill the provisions of this bill which would guard the public's interests, the committee has reported a substitute measure called the Myers bill, which, if enacted, would place the undeveloped water powers of the country unreservedly in the hands of the "interests" and completely tie the hands of the Government. Briefly, the provisions which would accomplish this are in substance as follows:

1. The Secretary of the Interior would be left no discretionary power, but it would be mandatory upon him to issue permits wherever requested.

2. The Government would be prevented from exercising the privilege of recapture before the expiration of fifty years.

3. At the expiration of fifty years the Federal Government would have the right to take over the properties at a "fair value"; but if it fails to do so the original lessee would have an option of renewal in preference to all other applicants. This would exclude any municipalities.

4. The term "fair value," although excluding franchise, permits the inclusion of all other intangibles and paves the way for an inflated capitalization, over which the Government would have no control, but for which it would have to pay if it should desire to take over the property at the end of fifty years.

5. After having issued the permit for a water-power development, the Government would have no control over its transfer or sale; in other words, a complete monopoly of the water powers might be effected and the people would have no redress.

6. The bill provides for development subject only to market conditions. While on the face of it apparently fair, this clause is dangerous in that no discretionary power is vested in the Secretary of the Interior and the potential water powers may be held for speculative purposes.

POWER ON NAVIGABLE STREAMS

The Shields bill, introduced by Senator Shields of Tennessee and relating to the development of water power on navigable streams, after being introduced on Feb. 7 was made the unfinished business of the Senate and was discussed for four days during the week of Feb. 14 without a definite decision having been reached. Minor amendments to the bill have been introduced by Senators Walsh, Norris, Kenyon and Husting, but with the exception of the first two named, the Senate has avoided consideration of any changes in the measure. The bill provides:

1. That the Secretary of War shall have authority to permit the construction, maintenance and operation of dams and accessory works for the development of water power on any of the navigable waters of the United States by political subdivisions of the states, municipal corporations, corporations, companies and associations.

2. That the plans and specifications for the dams and accessory works shall be submitted to the Secretary of War and the Chief of Engineers and approved by them, and that no changes in the original plans shall be valid unless so approved.

3. That the project adopted shall be such as in the judgment of the Secretary of War shall be the best adapted to a comprehensive plan for the improvement of the waterway in question for the uses of navigation and the full development of its water power and other beneficial public purposes and best adapted to conserve the water resources of the nation.

4. That the Secretary of War shall be given power to include any or all of the following provisions: (a) That the grantee shall preserve navigation facilities at least equivalent to those existing prior to the construction of the dam or power plant; (b) that the grantee shall reimburse the United States for the cost of any investigation necessary for the approval of the plans and for such supervision of construction as may be necessary in the interest of the United States; (c) that the grantee shall pay to the United States reasonable charges in consideration of the benefits accruing to and used by such grantee, the charges to be fixed by the Secretary of War; (d) that the grantee may, with the authority of the Secretary of War, occupy and use, to the extent necessary to the project

* See "Power," Mar. 31, 1915.

any lands of the United States, including the public lands, upon payment of reasonable charges.

5. That the Secretary of War shall have power to formulate rules and regulations governing the control of the level of the pools above and below the dams, the currents developed therein and the flow of the water over and past such dams and the operation of navigation facilities.

6. That no such permit shall relieve the grantee from liability to the damage occasioned to the property of others by the construction, maintenance or operation of the dam, and that the United States shall in no event be liable therefor.

7. That the permit shall remain in force for fifty years from the date of the commercial operation of the initial installation, unless revoked as later provided for.

8. That at any time after the expiration of fifty years the United States may terminate the rights granted by giving the grantee one year's notice in writing and upon paying to the grantee fair value for his property and assuming all contracts outstanding at this time. The Secretary of War is designated as the person who is to decide upon the "fair value."

9. That all charges for power furnished shall be in accordance with the laws of the state in which the service is rendered.

10. That any refusal or failure to comply with any section of this law shall subject the offender to a fine of $1,000, and that every month that the grantee remains at fault shall be considered a new offense and subject the grantee to additional penalties therefor.

11. That the grantee shall commence the construction of the dam and accessory works within two years from the date of the permit and shall thereafter prosecute such construction with due diligence and in good faith.

12. That the Secretary of War shall have the power to lease to any applicant the right to utilize the surplus water power over and above that required for navigation on such terms as the Secretary of War shall deem the best suited to the interests of the United States. The charges and rents arising from such leases are to be reserved and appropriated as a special fund in the Treasury for the maintenance of dams and the further improvement of waterways.

13. That the provisions of this act shall not apply to structures heretofore constructed or upon which construction has begun or to irrigation or power dams or grants to municipal corporations approved or erected under the jurisdiction of the Secretary of the Interior or the Secretary of Agriculture.

14. That the works constructed and maintained under authority of this act shall not form a part of any unlawful combination or conspiracy to limit the output of electric energy or in restraint of trade in the generation, sale or distribution of electric energy.

15. That the right to alter, amend or repeal this act is expressly reserved.

ACTION LONG DELAYED BY CONGRESS

When the bill was first formally opened to discussion, on Feb. 16, Senator Bankhead of Alabama drew the attention of the Senate to the fact that this measure has been in the hands of a committee of the Senate for four years, that it had been unanimously reported upon by the Committee on Commerce and that it was on the calendar of the Senate during the last Congress. He said:

So far as the committee was able to do so this bill has been carefully prepared. While of course I do not object to amending the bill—if an amendment is proposed that improves its provisions and its operations, that is proper and necessary—yet if we are to amend the bill in important particulars without knowing what the effect of the amendment is to be upon other important sections of the bill, we will practically destroy it in the end.

If we cannot frame here a bill that will protect the interests of the people of the states and of the Government, provide for navigation and at the same time put into the bill provisions that will be inviting to capital, we had just as well stop now. We have had that character of legislation on the books for ten years, and what has been accomplished under it? Not a single development that I am aware of has been commenced and completed under what is known as the General Dam Law now on the statute books, and it is my deliberate judgment that none ever will be. So that if Congress has reached the conclusion that these great natural resources should be utilized and in their utilization that the navigation of our rivers should be improved, we have an opportunity to do it here in this bill and at the same time protect the interests of the people and the states and the National Government.

Senator Walsh of Montana, after introducing several amendments to relatively unimportant provisions of the power bill, made a direct appeal to the Senate for rapid action on this matter. After pointing out the tremendous loss that the country is sustaining on account of the absence of such a law—a loss which the Senator from Montana approximated at $300,000,000 a year—he continued:

Consider the great power site on the Pend Oreille River, a site which would bring at least $3,000,000 if put up at public auction. The Pend Oreille River empties Flathead Lake, the largest body of fresh water between the Mississippi River and the Pacific Ocean. That lake empties into this river; it tumbles over a series of cascades seven miles in length that are capable of producing 250,000 hp., as much as the total development in our state. The lands on both sides are public lands. They are reserved from disposition under the present condition of things. Do you wonder that I am here urging that we give consideration to a measure which has some show of being enacted into law?

Moreover, as is well known, practically every developed power in our state belongs to the Montana Power Co. I do not want to say anything by way of criticism of that organization. It has exhibited in the conduct of its business a most commendable public spirit. It is extending its business into all sections of our state, and most liberal terms are being made. In front of my city is the fertile Prickly Pear valley. The Montana Power Co. is furnishing power to the farmers in that valley so that they can get water at much less cost than even the settlers under the reclamation projects. Twelve thousand five hundred acres is now under cultivation, irrigated by water that is pumped by this company by electrical power. As I say, however, practically every power in the state is in their hands and everything else is tied up. That is why we are so anxious to have this legislation.

OPPOSITION TO WATER-POWER BILL

In replying to the statements of Senator Walsh, Senator Shafroth, former Governor of Colorado, fired the opening gun of the opposition to the water bill by saying:

The Senator from Montana no doubt represents the people of Montana when he says that they are in favor of this legislation, but I must say to the Senator that that is not the view held throughout the West. So far as the people of my state are concerned, they believe that the power in the streams belongs to the people of the state and that the United States Government has no more right to hinder the construction of a power plant than a farmer would have the right to stop a railroad because the railroad wanted to go through his land. I wish further to state to the Senator that, while he honestly believes that there are people ready to enter into leasing contracts with the Government, I have no doubt that under the treatment which lessees of the Government have received in the past twenty years people will be very slow in their efforts to secure leasing contracts.

The opportunity for leasing and paying a royalty to the Federal Government is not one that is going to be seized readily by the people, because the Government has heretofore revoked permits without rhyme or reason, without suggesting a cause for its action. When the permit system was inaugurated for the construction of water-power plants it was said: "All we want to do is to stop one company from monopolizing; we want the privileges of a company, if it fails to proceed with construction work, to end; and therefore we want the privilege of revoking the permit." But there was one Secretary of the Interior who, without notice to a single water-power company and without any trial, issued an order revoking forty permits, where there had already been constructed and were in operation power plants that had cost millions of dollars and which at that very minute were transmitting electricity to various communities.

Senator Walsh's amendments, when voted upon on Feb. 16, were defeated by a vote of 36 to 15, and the Senator from Montana served notice that he would introduce other changes in the bill later on.

On the following day Senator Thomas of Colorado lined up with his colleague, Senator Shafroth, in opposing the bill. In concluding his speech, Senator Thomas said:

The title of this bill refers only to its ostensible purpose—its real purpose is to confer upon citizens and upon corporations the right to obstruct streams by proper dams constructed under the supervision of the War Department for the purpose of generating power and to which the matter of navigation is only incident. In other words, the bill proposes that the Government of the United States shall exercise its undoubted power to control navigation in the benefit and for the interest of great enterprises that have no legal connection therewith. The Government says to the individual: "I have the power to control navigation over this stream. I will therefore make an ostensible exercise of that power, not for the primary purpose of improving navigation, but for the purpose of creating a force in the stream which I will permit you to utilize provided the contract requirements of the law are complied with."

I contend that this is a perversion—and I say it with all respect of the great power of the Government—to a purpose and to an end that the power does not justify and the use of which was never contemplated by the framers of the Constitution.

Senator Norris of Nebraska called attention to the existing condition, which places the control of navigable streams in the hands of the Secretary of War and the control of public lands in those of the Secretary of the Interior. The Senator from Nebraska made the flat statement that it was this division of authority that led to the resignation of Secretary Garrison from the Cabinet and requested a change in the proposed law whereby the control of the lands and streams would be under one head. Discussion of this proposed amendment and others that will follow will probably prolong consideration of the bill for two or three weeks.

Detroit Orders Large Turbine

The Detroit Edison Co. has recently placed an order for a 45,000-kw. turbine, which will be the first unit of a proposed third plant at Delray. When first installed it will be supplied with steam from the older power houses on the same site, as there is sufficient surplus boiler capacity to make this possible.

PERSONALS

C. G. Elliott, of Washington, D. C., for ten years chief drainage engineer of the United States Department of Agriculture, has become affiliated with the Harman Engineering Co., of Peoria, Ill., which will hereafter be known as the Elliott & Harman Engineering Co. Mr. Elliott will act as consulting drainage engineer of the corporation and have charge of the Eastern branch office at 503 McLachlen Building, Washington, D. C. The home office is at 144 Fredonia Ave., Peoria, Ill.

BOOKS RECEIVED

MECHANICAL ENGINEERS' POCKET BOOK. By William Kent. Published by John Wiley & Sons, Inc., New York. Ninth edition. Leather; 1,567 pages; 4¼x7 in.; 249 illustrations; tables. Price, $5.

HANDBOOK OF CARBURETION. By Arthur B. Browne. Published by John Wiley & Sons, Inc., New York. Cloth; 137 pages; 6x9 in.; 47 illustrations; tables. Price, $2.

ENGINEERING AS A CAREER. By F. H. Newell and C. E. Drayer. Published by D. Van Nostrand Co., New York. Cloth; 214 pages; 5x7 in. Price, $1.

MECHANICAL DRAFTING. By Charles B. Howe. Published by John Wiley & Sons, Inc., New York. Cloth; 147 pages; 11x8 in.; 116 illustrations. Price, $1.75.

OXY-ACETYLENE WELDING AND CUTTING. By Harold P. Manly. Published by Frederick J. Drake & Co., Chicago, Ill. Cloth; 215 pages; 4¼x6¾ in.; 56 illustrations. Price, $1.

ENGINEERING AFFAIRS

The New York State Association of the N. A. S. E. will hold its annual convention at Yonkers during the month of June, instead of at Saratoga, the place first selected.

The Thirteenth Annual Masque Ball of Local No. 68, International Union of Steam and Operating Engineers, was held Monday evening, Feb. 21, at Reiff's Colosseum, Newark, N. J. The usual large crowd was present.

International Engineering Congress, 1915—The Committee of Management announces that the volume on Mechanical Engineering is ready for distribution and the members that have subscribed to this volume will soon receive it. The other volumes will be issued as rapidly as possible. It is hoped that within two months the entire set will be completed.

Detroit Engineering Society—On Mar. 3, Dr. Allen Rogers, of the laboratory of industrial chemistry, Pratt Institute, Brooklyn, N. Y., gave an illustrated lecture on "The Manufacture of Leather from the Hide to the Finished Product," and on Mar. 17, John H. Willer, superintendent of labor, Packard Motor Car Co., will speak on "Modern Shop Tools and Methods for the Production of Automobile Parts."

The National Convention Committee of the National Association of Stationary Engineers has been appointed as follows: Chairman, Jesse Williams; vice-chairman, A. Johnson; secretary, J. F. Gould; treasurers, H. F. Miller, John D'Arcy. Advisory committee: Governor Burnquist, Mayor Nye, of Minneapolis; ex-Mayor Keller, of St. Paul; Mr. Hillwig, Chamber of Commerce; Professor Flather, University of Minnesota. The convention will be held in the Armory, which will accommodate both exhibits and meetings. The West Hotel will be the headquarters.

Phillipsburg, N. J., No. 10, a new association of the N. A. S. E., was instituted on Saturday, Feb. 12, by State Deputy John J. Reddy, with 43 members. The officers elected were: C. T. Reynolds, president; Eldridge Robbins, vice-president; C. E. Pihl, financial secretary; Charles Worth, corresponding secretary; Valette V. Secor, recording secretary; Stewart M. Kenney, treasurer; William H. Kirkendale, conductor; William Rose, doorkeeper; Harry Race, past-president; Simon Johnson, George W. Kells, Samuel Wilson, Harry Oliver, William Moyer, trustees. The officers were installed by Past National President William J. Reynolds. The three members of the New Jersey State Board of Examiners—Arthur L. Case, Martin J. Hickey and Joseph Scott—were present; Mr. Case and Mr. Hickey made interesting addresses, and Mr. Scott sang. Short talks were given by John J. Callahan, New Jersey Association, No. 1; George R. Stars, of Greene, Tweed & Co.; Frank Tuthill, of McLeod & Henry Co.; Denis F. Bartley, state president; Frank H. LePoint, chairman of license committee, and James Heath, state secretary. Past National President William J. Reynolds spoke interestingly of the "National Engineer." At intervals Jack Armour, of "Power,' told stories and recited. Refreshments were served. The meeting place of the association will be Redman's Hall. Before adjournment the members indorsed the candidacy of John J. Callahan for the office of national vice-president.

Classified Ads

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RATES: Positions Wanted, 3 cents a word, minimum charge 50 cents an insertion, payable in advance. Other advertisements, 5 cents a word, minimum charge $1.00. Count 4 words for blind address care of our New York or Chicago offices. Advertisements for bids $3.60 an inch.

ANSWERS addressed to us at 10th Ave. and 36th St., New York or 1144 Monadnock Block, Chicago will be forwarded without charge (excepting circulars or similar literature).

IMPORTANT: Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents—send copies. Advertisers' names will not be furnished under any circumstances. Copy received until 10 A.M. Tuesday for following Tuesday's issue. P

POSITIONS OPEN

Michigan

CHIEF ENGINEER wanted for large steam turbine plant; also switchboard operators for generating and sub-stations; must be experienced and familiar with high-tension apparatus; location, Middle West. P720—Power, Chicago.

New York

LARGE POWER STATION in New York City has openings for bright, studious young men from out of town (preferably ing groups of two or three); excellent opportunity to advance; employment offered as stoker operators (2) at $2.35 per day; oilers (4), $2; machinist's helpers (3) at $2.25; blacksmith at $3.25 and water tenders (2) at $2.60 per day; work eight hours per day, seven days per week; if interested, submit an application giving full information as to education, experience and ability. P735—Power.

Pennsylvania

SEVERAL FIRST-CLASS DRAFTSMEN wanted at once, of general mill and blast furnace experience; state age, experience, present salary and salary wanted in first letter; also when available; central location, Pittsburgh. P687—Power.

SEVERAL DRAFTSMEN wanted at once, experienced in power plant and general piping work; state age, experience, present salary and salary wanted in first letter; also when available; central location, Pittsburgh. P688—Power.

COMBUSTION ENGINEER and boiler-room foreman wanted, who can produce results; applicant please state age, experience, education, the plants connected with and results obtained, list of references, salary expected and when he can report. P725—Power.

SUPERINTENDENT wanted for power plant; must be familiar with both turbines and Corliss engines; must be an A-1 man, who can get the best results out of the plant; in reply state age, experience, conditions existing at and results obtained from previous plant under your charge; also give references, state salary expected and when you can report. P726—Power.

Employment Agencies

CORRESPONDENT

THE UNDERSIGNED plans and conducts correspondence for positions in technical, manufacturing and prcfessional lines; $2500 to $15,000 men exclusively; complete privacy assured; no commission charged—only service fee and postage. Send name and address only, in confidence, for prefatory details. R. W. Bixby (established 1910), P1 Niagara Square, Buffalo, N. Y.

POSITIONS WANTED

Kansas

CHIEF ELECTRICIAN; steam, mechanical, electrical, experienced on cranes ,handle men, splice rope and cable, winding a. c. and d. c.; competent to handle plant; technical education; references; now employed. PW728—Power, Chicago.

New Jersey

HAVE STATIONARY STEAM ENGINEER'S LICENSE for plants of any horsepower (operator licence); have had three years' experience grinding rolls, iron, wood, rubber, copper, brass, chilled iron and steel; have had five years' experience in machine shop; these are all paper mill work; am employed. PW727—Power.

New York

POWER-PLANT OPERATING ENGINEER or assistant; licensed man; experienced in the care and operation of engines, boilers and auxiliary equipment; immediately available; location immaterial. PW678—Power.

SALES ENGINEER, five years with engineering firm designing, building and selling electric, pumping and manufacturing plants, seven years sales representative of valve company desires connection; age 32. PW736—Power.

WANTED

MANUFACTURER wants either patented or patentable ideas on boiler and engine room specialties; cash or royalty basis. W676—Power.

AGENTS AND SALESMEN

FALL RIVER MECHANICAL ENGINEER will follow up your sales inquiries in Fall River district on commission basis. W729—Power.

AMBITIOUS SALESMEN acquainted with steam trade; a brand new high-class specialty; orders $10 and up; 30% profit. Address in confidence, W724—Power.

HAVE YOU SUCCESSFULLY SOLD a steam specialty? You can make a profitable connection with an old-established line which sells to power plants everywhere; extensively advertised—unusually liberal contract. W731—Power, Chicago.

A LIVE POWER-PLANT SPECIALTY SALESMAN who can qualify will have an opportunity to join the sales force of a well known manufacturer on a commission proposition, offering extraordinary returns. Send details to W732—Power, Chicago.

AGENTS handling engine and boiler room specialties, in every section, for side line, paying large commissions. Give experience, lines carried and territory covered. W390—Power.

AGENTS on commission to sell our Shaking Grates; we will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio.

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MISCELLANEOUS

PATENT ATTORNEYS

PATENTS. C. L. Parker, patent attorney, formerly member Examining Corps, U. S. Patent Office, McGill Bldg., Washington, D. C. Inventor's handbook sent upon request.

IS YOUR INVENTION VALUABLE? Ask A. P. Connor, electrical, mechanical engineer (ex-chief electrical engineer for New York). Patent attorney. Lawyer. Carroll St., S. E., Washington, D. C.

FOR SALE

FOR SALE—Nine bound volumes "Power," in gray buckram, 1909-1913 inclusive, indexed and in good condition; no fair cash offer refused. Box 612, Wheeling, W. Va.

CONTRACTS TO BE LET

Bids received until Mar. 18, 1916.

Internal Combustion Engine for Pumping Station

Wheaton, Ill.

Sealed proposals will be received by the City Council of the City of Wheaton, Illinois, on Saturday, March 18, 1916, at 7 o'clock P.M. in the council chambers, City Hall, Wheaton, Illinois, for the furnishing and erection complete of an internal combustion engine of not less than 90 brake horse power. Bidders may make proposals on an oil engine or a gas producer and gas engine outfits.

Proposals must be enclosed in a sealed envelope endorsed "Proposals for the furnishing of an internal combustion engine at Wheaton, Illinois," and directed to La Verne J. Ruddock, City Engineer, Wheaton, Illinois.

No bid will be considered unless accompanied by a certified check for ten per cent. of the amount bid, drawn upon a state or national bank, and made payable to Arthur L. Perrottet, Mayor.

A satisfactory surety bond of forty per cent. of the amount bid will be required of the successful bidder conditioned upon the faithful performance of the work.

Specifications and drawings can be seen and secured at the office of La Verne J. Ruddock, City Engineer, Wheaton, Illinois.

The City Council of the City of Wheaton, Illinois, reserve the right to reject any or all bids or waive any informality of bid if it is considered in the best interest of the City of Wheaton so to do.

LEWIS ELLSWORTH, City Clerk.

Dated at the City Clerk's office, Wheaton, Illinois, February 26th, 1916.

For Sale
Second Hand Equipment

Rates: Less than 4 insertions 75 cents per line—4 to 11 insertions 70 cents per line—12 or more insertions 65 cents per line.

Equipment Wanted items appear at the end of this list.

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NEW RIVER CO., The, MacDonald, W. Va.

BOILERS

150 H. P. water tube. 135 lbs. pressure allowed by inspector.—Schultz, Baujan & Co., Beardstown, Ill.

CONDENSERS

Ready for immediate shipment, one 4,000-sq.ft. surface condenser, rectangular shell, brass tube and glands, steel tube heads, top exhaust opening circular, 28" diameter. Full particulars upon application. Platt Iron Works, Dayton, Ohio.

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Direct current, 250-500 V., cap. up to 250 KW.—NEW RIVER.

Engine and Generator—One Hamilton Corliss 18x36x42" horizontal cross compound engine with 14x16" cast iron flywheel; direct connected to Westinghouse 580-kw. generator, 440 v., 761 amp., 3-phase, 25-cycle, 107 r.p.m. Generator is revolving field; the Exciter is steam driven. No Switchboard with this outfit. Engine now running condensing. All of the equipment, such as pumps and piping, is in connection with the Engine. The condenser is of the surface type. 140 lb. steam pressure used. Floor space 21 ft. 8 inches wide—28 ft. long over all. Equipment has been in operation five years and can be seen in operation during February and March at our Cedar Rapids Mill. For price and full information address National Oats Co., St. Louis, Mo.

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Pipe and fittings, screwed & flanged, 7 to 18".—NEW RIVER.

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High head, general service and boiler feed.—NEW RIVER.

WANTED

Second hand Ideal engine, 200 revolutions, 16x20 cylinder. Engine built for direct connection. W733—Power.

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